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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS
SECTION B, ELECTRICAL ENGINEERING

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ABSTRACTS 7372–8174

ME 56 **NOVEMBER 1953** NUMBER 671

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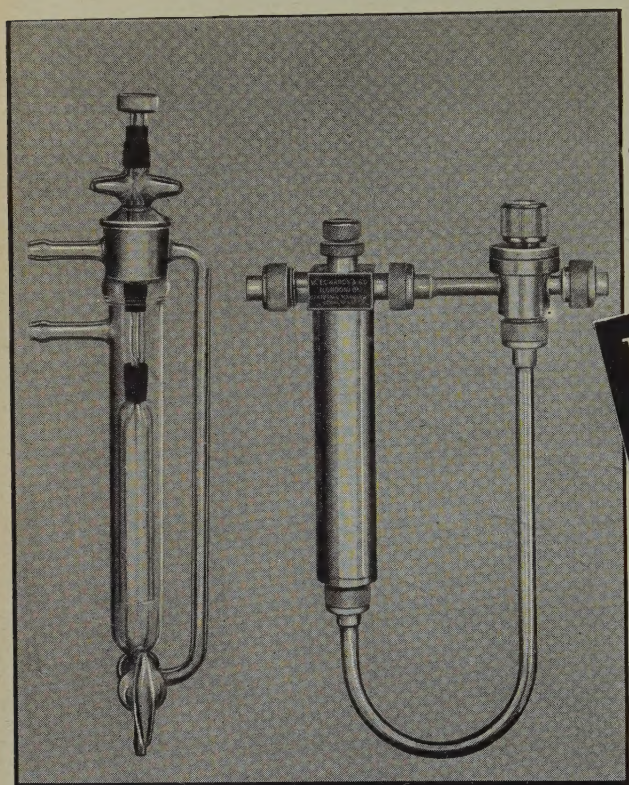

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Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, Lo W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accept errors.

Annu. Rep. Sci. Works Fac. Sci. Osaka Univ.	*Annual Report of Scientific Works from the Faculty of Science, University.* Osaka University, Nakanoshima, Osaka, Japan. places *Science Papers from Osaka University*, which ceased publi at the end of Volume 36.]
Bull. Acad. Polon. Sci. Cl. 4	*Bulletin de l'Académie Polonaise des Sciences: Classe quat Mécanique appliquée, Electrotechnique, Science des Mines, Métal Construction mécanique, Génie civil, Architecture.* Polska Aka Nauk, ul. Nowy Świat 72, Warsaw.
Mater. and Methods	*Materials and Methods.* [Abstracted by Metropolitan-Vickers Ele Co.]
Matronics	*Matronics.* Philips Gloeilampenfabrieken, Eindhoven.
Tele-Tech	*Tele-Tech.* 480 Lexington Avenue, New York 17, N.Y.
U.S. National Sci. Found.	*U.S. National Science Foundation.* Translations of Russian ar see note on opposite page.

New Journal

Indian J. theor. Phys.	*Indian Journal of Theoretical Physics.* Editorial Secretary, 18 Ram Bose Street, Calcutta 3, West Bengal, India. Volume 1, No. 1 June, 1953. Subscription rates: Annual, Rs. 10/- (Inland), Rs (Foreign). Single copy Rs. 3/- (Inland), Rs. 3/8/- (Foreign).

Notes

Communications and Electronics	Nos. 1–4 of this publication are issued in collected form in *Transa of the American Institute of Electrical Engineers*, Vol. 71, Pt I wi change in pagination.
Applications and Industry	Nos. 1–4 of this publication are issued in collected form in *Transa of the American Institute of Electrical Engineers*, Vol. 71, Pt II, wi change in pagination.
Power Apparatus and Systems	Nos. 1–3 of this publication are issued in collected form in *Transa of the American Institute of Electrical Engineers*, Vol. 71, P without change in pagination.
Czechoslovak Journal of Physics	Change of address: Czechoslovak Academy of Sciences, Národní Prague I; Editorial: Cukrovarnická 10, Střešovice, Prague.

Errata

Abstr. 6811 (1951) line 2: *for* 21–3 *read* 62–4.

Abstr. 6299 (1953) line 14: *for* absorption *read* adsorption.

MATHEMATICS 51

512.9

A note on Milner's $\mathscr{E}$-numbers. C. W. ISTER. *Proc. Roy. Soc. A*, **217**, 144–8 (*June* 9,

cent results of Milner [Abstr. 7865–6 (1952)], n appeared to require an extension of the tensor lus, are extended and generalized. It is shown Milner's suggested extension is, in fact, un- sary. A.

517.522

Summation of slowly converging series. UMOWSKI. Letter in *J. appl. Phys.*, **24**, 1068 ., 1953).

518.1

A set of principles to interconnect the solutions ysical systems. G. KRON. *J. appl. Phys.*, **24**, 30 (*Aug.*, 1953).

set of principles and a systematic procedure are nted to establish the exact solutions of very and complicated physical systems, without ng a large number of simultaneous equations without finding the inverse of large matrices. procedure consists of tearing the system apart several smaller component systems. After lishing and solving the equations of the com- nt systems, the component solutions themselves nterconnected to obtain outright, by a set of formations, the exact solution of the original m. The only work remaining is the elimination olution of the comparatively few superfluous traints appearing at the points of interconnection. method shown may be extended and generalized at one can tear apart and afterward reconstruct solution of extremely large or highly intricate ical systems, often without calculating any se matrices at all and always without carrying g unduly large matrices. Those versed in ten- l analysis of interrelated physical systems and of electrical networks should thereby be able to , with the aid of digital computers, highly plex physical systems possessing tens of thousands in special cases, even hundreds of thousands of ables. The saving in computing time is consider- even in smaller problems; by tearing a physical m into n parts, the usual machine calculations reduced, in matrix inversion for instance, to a ion of about $2/n^2$. The solution of a simple dary value problem of Poisson's equation is loped in detail. A.

518.2

Tables of associated sine and cosine integral ions and of related complex-valued functions. E. BLEICK. *United States Naval Postgraduate ol, Monterey, California. Tech. Rep. No.* 10, p. (*May*, 1953).

e associated sine and cosine integral functions,

$$\mathrm{Sia}(x,y) = \int_0^x \frac{t \sin t\, dt}{t^2 + y^2}$$

and

$$\mathrm{Cia}(x,y) = \int_\infty^x \frac{t \cos t\, dt}{t^2 + y^2}$$

used in studies of rhombic aerials, are tabulated for $x = 0(0{\cdot}1)3{\cdot}1$ and $y = 0(0{\cdot}1)3{\cdot}1$. These functions have been evaluated in terms of the sine and cosine integral functions, $\mathrm{Si}(x + jy)$ and $\mathrm{Ci}(x + jy)$ for complex argument $x + jy$, which are also tabulated for the same values of x and y. Power series and asymptotic series are given for the four functions. A.

518.5 : 621.318.572 : 681.142

7376. Micro-programming and the design of the control circuits in an electronic digital computer. M. V. WILKES AND J. B. STRINGER. *Proc. Cambridge Phil. Soc.*, **49**, *Pt* 2, 230–8 (1953).

The control section of a machine is the most complex and the most difficult to design logically. Basic machine operations can be considered as made up of a micro-programme of micro-operations and it is the design of this programme which is here considered. It is assumed that the machine is a parallel one, that a permanent rapid-access storage device exists and that the micro-orders can be executed one after another. An example is treated. Possible extension to serial machines is noted.

A. J. KENNEDY

519.2

7377. An equipartition principle of generalized canonical ensembles. H. L. FRISCH. *Phys. Rev.*, **91**, 791–3 (*Aug.* 15, 1953).

The equipartition of energy of a canonical ensemble has in the past proved fruitful in deriving averages of interesting parameters. It can be shown that an analogous principle holds for a generalized canonical ensemble, i.e. one whose distribution depends on a set of "additive" parameters a_i. With the help of this generalized equipartition principle one can calculate averages of certain functions of the co-ordinates that may be of interest. At equilibrium the equipartition principle reduces to the classical result provided that one of the a_i's (or a sum of them) is the Hamiltonian of the system. The principle is applied to two weakly interacting gases and a gas described by two integrals of the motion. A.

519.24

7378. The determination of the parameters of an experimental law by the condition of least imprecision. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **236**, 2037–9 (*May* 27, 1953) *In French.*

It is shown by examples, in particular the determination of the term Ax^2 in a representative law of the second degree, that in simple cases where the parameters are linear relations of the data, the experimental error has least effect when the data, assumed very numerous, have the same absolute coefficient but are grouped, according to the signs of their coefficients, into as many groups as the law contains parameters. S. WEINTROUB

519.24

7379. The determination of the parameters, or of a function of parameters, of an experimental law, by the condition of least imprecision; simplification by weighting. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **236,** 2389–91 (*June* 22, 1953) *In French.*

[See previous abstract.] The error in the result is linearly related to the errors in the data. The imprecision is least when the coefficients common to the two groups, corresponding to errors with positive and negative coefficient respectively, are in the ratio of the square roots of the numbers of their constituents.

S. WEINTROUB

511

7380. The "best" straight line among the po R. H. BACON. *Amer. J. Phys.*, **21,** 428–46 (S 1953).

The familiar method of fitting a straight line set of experimentally observed points by use of squares, is reviewed, and variations of it briefly cussed. Then methods, apparently not so fam to many physicists, for estimating the adequacy o fit thus obtained, and for comparing the resul several such experiments, are explained. A few c principles of mathematical statistics underlying methods are given in the appendix.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

7381. The rocket and the future of astronomy. A. C. CLARKE. *Occ. Notes Roy. Astron. Soc.*, **2,** 127–66 (*Dec.*, 1952).

Summary of present achievements in rocketry of interest to astronomers and assessment of possibilities for future. Covers fundamentals, high-altitude research, earth-satellite vehicles, escape missiles, spaceships, space-medicine and astronomical problems. Concludes that, with existing techniques, small automatic missiles could be put into stable orbits around Earth and later of Moon and planets. Economical development of space travel only possible by production of efficient atomic drive and by obtaining propellant mass from sources of low gravitational potential (e.g., Moon, asteroids, smaller planets).

522.2 : 621.396.677

7382. A high-resolution aerial for radio astronomy. W. N. CHRISTIANSEN. *Nature* [*London*] **171,** 831–3 (*May* 9, 1953).

An aerial system giving high resolution in one co-ordinate has been constructed following a principle analogous to the diffraction grating of optics. The actual system consists of 32 6 ft paraboloids individually mounted on polar axes arranged at equal intervals on a 700 ft east-west line. On 21 cm wavelength, the system gives a family of knife-edge beams of 3′ in width separated by 1·7°, which is swept across the disk of the sun by the rotation of the earth. Provisional observations on bright areas and the general distribution of radiation across the solar disk at this wavelength are reported; some limb-brightening is indicated.

M. W. OVENDEN

522.53

7383. Two instruments [giving] double images with a large separation for micrometric measures in astronomy. P. MULLER. *C.R. Acad. Sci.* [*Paris*] **236,** 1953–5 (*May* 18, 1953) *In French.*

The author claims priority for a theoretical solution of the double-image micrometer problem (1937), and describes a practical utilization of the principles laid down. A prism giving constant angular image-separation under normal incidence is inserted in a collimated beam, resulting in a marked improvement in image quality over that obtained by Dollfus [Abstr. 2904 (1953)].

D. R. BARBER

52

7384. New methods of cosmological investiga F. ZWICKY. *Helv. phys. Acta*, **26,** *No.* 3–4, 24 (1953) *In German.*

It is shown that a decision for or against the cept of the expanding universe is not possible on basis of nebular counts. Also, all methods w involve the determination of absolute distances absolute magnitudes of nebulae are most unreli because of the recent discovery of intergalactic ma The author has therefore developed new mode approach to cosmological problems which belon the realm of *dimensionless morphology*. These inv only the three basic operations of identifica counting and the use of coincidence conditi These operations have been applied to the large-s distribution of stars, nebulae and clusters of nebu It is shown in particular that from a study of distribution of the large clusters of galaxies following three problems can be solved. First, existence of intergalactic dust can be ascertai Second, critical tests may be devised which allow us to decide whether or not the univers expanding. Third, the luminosity function of clu nebulae can be derived, and it is found that function does not possess any maximum, as been claimed by many observers, but it is increa monotonously with decreasing brightness of nebulae.

52

7385. Evolution of stars. B. STRÖMGREN. *Astron* **57,** 65–83 (*June*, 1952).

Extensive critical review and further developm of the present status of research into stellar evolut Four main sections deal with:—(1) Problems stellar models. (The sun; stars on the main seque below and above the sun; subdwarfs; subgia giants and supergiants; white dwarfs.) (2) Ev tionary changes of a star's chemical composit mass, type of model, rotational moment. (The t scale; conversion of hydrogen into helium; mi of matter in stellar interiors; changes of structu changes through accretion; loss of mass caused radiation pressure at the surface and by rotati (3) Formation of stars. (Creative role of interste matter; accretion around existing slow-moving sta

ew interpretations of the Hertzsprung–Russell am, with particular reference to problems of evolution. (The parameters: mass, original cal composition, age, rotation; the various ries of sequences; populations I and II; novae upernovae; stars of peculiar chemical com- on; diagrams of open star clusters.) Concludes modern bibliography. A. BEER

523.16 : 537.52

Conditions for the occurrence of electrical rges in astrophysical systems. J. W. DUNGEY. *Mag.*, **44**, 725–38 (*July*, 1953).

charges are shown to be a possible source of nergy particles, if the current density is very The growth of the current density is discussed the fact that the magnetic lines of force are ximately frozen into the ionized gas. It is that discharges are unlikely to occur anywhere at neutral points of the magnetic field. Neutral are found to be unstable in such a way that a perturbation will start a discharge in a time of rder of the characteristic time of the system. discharges may account for aurorae, and may ccur in solar flares and the interstellar gas. A.

523.161

A possible source of the kinetic energy of ellar matter. V. S. SAFRONOV. *Dokl. Akad. SSSR*, **89**, *No.* 6, 987–90 (1953) *In Russian.*

523.162

Law of variation with wavelength of the ient of continuous absorption of interstellar L. DIVAN. *C.R. Acad. Sci.* [*Paris*] **236,** 3 (*June* 15, 1953) *In French.*

a comparison of the continuous spectra of 2 of identical type, one of which is situated in a of interstellar dust, optical density, A_λ, it is that the following relation holds: $A_\lambda = K_\lambda$, where K_λ is the absorption coeff. and M is nount of interstellar material in the line of sight. l vary from one star to another, the unit being d as that quantity required to produce a colour of unity on the Stebbins scale. The law of ion with λ has been examined over the range to 6100 Å, and found valid for stars in the is region; and also for stars in Cepheus, peia, Perseus, Orion and Sagittarius. Absorp- the Orion nebula follows the same law when ned in various directions in space, at least over nge 4000 Å to 6100 Å, a result contrary to those ed by Baade and Minkowski: Stebbins and ord (1940). For stars in the Cygnus region, a f K_λ v $1/\lambda$ is found to be linear between 3100 Å 000 Å: for longer wavelengths K_λ is smaller dicated by extrapolation. D. R. BARBER

523.162

An attempt to determine an absolute value of efficient of continuous absorption of interstellar J. BERGER, L. DIVAN AND A.-M. FRINGANT. *cad. Sci.* [*Paris*] **236,** 2379–81 (*June* 22, 1953) *ch.*

law of variation with wavelength of absorption erstellar dust (see preceding abstract) is applied case of 3 stars associated with ζ Persei, all of l type B3, but differently reddened, one being behind, and two in front of the absorbing cloud. A mean absorption of 6·5 mag. per unit colour excess on the Stebbins scale is found for the cloud.

D. R. BARBER

523.165

7390. Origin of supernovae outbursts. É. R. MUSTEL'. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 505–8 (1952) *In Russian.*

Evidence to support the author's contention, implicit in his hypothesis about supernovae, that the latter have even larger masses than novae, is adduced from the progressive increase in the red-shifts of absorption bands of supernovae in the blue region, as their brightness decreases, from the mass of the material ejected during an outburst, and from the small angular spread of radiowaves emanating from the region of the crab-like nebula. The basic observational tasks in this field are considered to be: (*a*) search for red-shifts in the spectra of declining novae; (*b*) search for a possible red-shift in the absorption lines from N.Aql.1918, before flare-up; and (*c*) further investigation of binaries like TCrB, with evaluation of stellar masses, and paying special attention to changes in the position of the emission bands and absorption lines in the spectra of repeating novae. R. C. MURRAY

523.165

7391. Nature of the radiation from radio stars. I. S. SHKLOVSKII. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 509–12 (1952) *In Russian.*

The mechanism proposed by Alfven and Herlofson [Abstr. 7337 (1950)] for the emission of radiowaves from stars (retardation of the electronic component of cosmic rays from these stars by the weak magnetic field in the surrounding cloud of ionized instellar gas) can only explain the radiation from powerful radiostars, and not that from the much more numerous "ordinary" stars, since these are well away from the galactic plane in regions of low interstellar gas density. Radiation from these may arise through retardation of relativistic protons by the strong magnetic field of the stars' own atmospheres. Calculations based on Mustel's ideas (preceding abstract) about the nature of supernovae suggest that the radiostars, at least in the crab-like nebula, are declining (or developing?) supernovae. The possibility of synthesis of heavy elements in supernovae is briefly discussed. R. C. MURRAY

523.165

7392. Simultaneous observations of radio star scintillations on two widely spaced frequencies. K. BURROWS AND C. G. LITTLE. *Jodrell Bank Ann.*, **1,** 29–35 (*Dec.*, 1952).

Observations of the scintillation of a radio star have been made simultaneously at frequencies of 81·5 and 118·5 Mc/s. The average cross-correlation coefficient between the scintillation records on the two frequencies was 0·61, with a standard deviation of 0·13. No systematic variation of cross-correlation coefficient with fluctuation rate or source elevation was found; the correlation showed a tendency to decrease with increasing amplitude of fluctuations. The experimental results are in general agreement with previous observations in England, but do not agree with earlier observations in Australia. A.

523.165

7393. A model of the radio-frequency radiation from the Galaxy. R. H. BROWN AND C. HAZARD. *Phil. Mag.*, **44**, 939–63 (*Sept.*, 1953).

A model of the Galaxy has been constructed which represents satisfactorily the radio-frequency surveys which have been made in the range 18·3 Mc/s to 1200 Mc/s. The model consists of a system of localized sources which are highly concentrated in the centre of the Galaxy and a disk of ionized interstellar gas whose properties are consistent with visual observations. It is suggested that the sources are rare members of Baade's population II and that they may be identified with the intense sources which have been observed to lie close to the galactic plane. The model requires the existence of a large isotropic component of radiation whose origin is probably extra-galactic. A.

523.5

7394. Radio echo observations of the daytime meteor streams in 1952. M. ALMOND, K. BULLOUGH AND G. S. HAWKINS. *Jodrell Bank Ann.*, **1**, 13–21 (*Dec.*, 1952).

Observations of the daytime meteor streams have been continued in 1952. Radiant positions were obtained for four permanent streams—the η Aquarids, Arietids, ζ Perseids and β Taurids, and a mean ephemeris of the radiant motion is given in the latter three cases. Measurements of the activity of stream and sporadic meteors are given for the period from May 1 to July 31. The determination of 65 meteor velocities during this period made possible the computation of the orbital elements of the Arietid and β Taurid meteor streams. The radiant positions, velocities and orbital data are in agreement with the measurements of previous years. A.

523.531

7395. The orbit of the δ Aquarid meteor stream. M. ALMOND. *Jodrell Bank Ann.*, **1**, 22–8 (*Dec.*, 1952).

Observations made at Jodrell Bank in July, 1952, to determine the velocity of the δ Aquarid meteors are described. The mean velocity has been calculated and used to compute an orbit for the meteor stream. This orbit is shown to resemble that of the daytime Arietids, thus confirming a previous suggestion that the two showers are due to a single stream of meteors. A.

523.6

7396. The comets and their origin. R. A. LYTTLETON. *Cambridge: University Press*, x + 173 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 286 (*Sept.*, 1953).

523.72

7397. A note on the long-period variation in the radio-frequency radiation from the quiet sun. T. HATANAKA AND F. MORIYAMA. *Publ. Astron. Soc. Japan*, **4**, *No.* 4, 145–51 (1953).

The apparent temperature of the quiet sun measured at radio frequencies is calculated for various values of the electron density in the corona and chromosphere to see how it changes during a sunspot cycle. The electron temperature in the chromosphere is assumed to increase exponentially with height until it reaches a constant value in the corona. The electron density in the corona is supposed to vary by a factor during a whole sunspot cycle without any chan the form, but in the chromosphere is assume vary in two different ways. The observation Covington at 10·7 cm over 5 years seem to fi calculated curve, while the decrement of the app temperature as given by Christiansen and Hind on 5 frequencies between two periods seems n well fitted, although the existence of a maximu the variation of the apparent temperature at a quency of about 1000 Mc/s is confirmed both theory and observation.

523.72 : 52

7398. On the directivity of solar radio emission the sunspots. T. TAKAKURA. Note in *J. Phys. Japan*, **8**, 422 (*May–June*, 1953).

Considering the intensity of solar radio emi to be linearly related to the relative sunspot num appropriate to the central ($\frac{1}{2}$ diameter circle) and solar zones, various measurements are analyse show that "enhanced" radio emissions ma regarded as the superposition of a non-directive directive emission. The latter disappears for quencies $> \sim 3000$ Mc/s, but directivity incr markedly as the frequency decreases from this va G. M. BR

52

7399. Radioelectric radiation from sunspot 160 Mc/s, 1948–51. M. JORAND. *Ann. Astrop* **16**, *No.* 3, 151–61 (1953) *In French.*

A statistical study of records obtained from 1948, to March, 1951, indicates an effect of sun activity which is most evident from the 4th preceding, to the 3rd day following central mer passage of the spot; thus suggesting an emissio radiation which has an average E → W direc and originates at a height corresponding to solar radius. D. R. BA

523.746 : 551.

7400. Information concerning the 80-year su cycle in ancient auroral observations. W. GLEISSB Letter in *Naturwissenschaften*, **40**, *No.* 12, 336 (*In German.*

Attention is drawn to the fact that ancient re of aurorae occurring in the epoch A.D. 5 to 7 [Schove: *J. Brit. Archaeol. Assoc., III Ser.*, 1 (1950)] reveal in addition to the well-known periodicity of occurrence, a long-period fluctuati 73 yr which may represent the influence of a suspected 80 yr cycle of sunspot activity. D. R. BA

52

7401. Kinetic temperature of the chromosp S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **3**, *N* 67–73 (1951).

The implication of the high kinetic temperatu the chromosphere proposed first by R. O. Rec from his observation of line width is developed. subjects considered are: the metallic ioniza chemical composition; energy distribution of Ba continuous radiation; the Balmer discontinuity intensity of cm-noise; the emission curve of gr for Ca II, H and K lines; helium and hydr spectrum. All available data indicate the perature to be much lower than 30 000°. Con

onger chromospheric lines are affected by the sorption. The large width of Balmer lines accounted for by the self-absorption with the emperature 5700° and with the second level ation derived by R. N. Thomas from the r decrement. A.

523.752

Electron temperature of the chromospheric on. Z. SUEMOTO. *Publ. Astron. Soc. Japan*, **3**, 110–25 (1951).

spectrogram of the chromospheric eruption of ary 28, 1951, near the Balmer series limit was d. Contours of H_{10}, λ3737 of Ca^+ and λ3720 were measured in order to obtain the numbers tive atoms. Considerations of the ionization d that these densities are incompatible with an on temperature higher than 20 000°. Most electron temperature of the eruption was nined to be about 13 000°, whereas the density drogen atoms at the base of the eruption was ated to be of the order of 5×10^{13}. Discussions vour of the low electron temperature of the al chromosphere are also given. A.

523.852 : 523.877

Evaluation of the population of the unstable in the helium atom in stellar envelopes and ae. A. A. NIKITIN. *Dokl. Akad. Nauk SSSR*, *o.* 2, 285–6 (1952) *In Russian.*

lculations, based on observations on the sun's and the nebula in Orion in different years, for ines λ10830 (2^3S—2^3P) and λ20582 (2^1S—2^1P) that the intensity of these lines varies with time, that the equivalent width of the absorption varies within the limits of 2 Å and 100 mÅ. It o calculated from the observed intensities that gaseous component of the diffuse nebula in n must have about 10 times the mass of the sun.

R. C. MURRAY

523.852.3

Photoelectric photometry of extra-galactic ae. J. H. BIGAY, R. DUMONT, F. LENOUVEL AND UNEL. *Ann. Astrophys.*, **16**, *No.* 3, 133–8 (1953) *ench.*

extension of a previous photometric survey photographically [Abstr. 2360 (1952)]. A multiplier was used to measure both blue and w magnitudes for each of the nebular objects ined; and the photometric measures were reduced nternational photographic, and photovisual itudes from which international colour indices derived. Results are listed for 19 nebulae in the C. catalogue. D. R. BARBER

523.872

. On the absorption lines formed in stellar spheres. S.-S. HUANG. *Ann. Astrophys.*, **15**, 2, 169–83 (1952).

e Schwarzschild integral equation for the source ion was solved by the method of series expansion. nulae have been given for the line profile (both ne flux and for the intensities) in the case of small scattering free from any other limitation such as magnitude of the line absorption and the strati- on of the atmosphere. A.

523.877

7406. Radiation pressure and stability of the atmospheres of early-type stars. S. MIYAMOTO. *Publ. Astron. Soc. Japan*, **4**, *No.* 2, 91–9 (1952).

The stability of the upper atmosphere is investigated against the radiation pressure. The radiation pressure due to the Lyman continuous radiation is the most important factor. The electron scattering becomes important among the hottest stars. The atmosphere is stable when the criterion Γ is small, and the static solution is lost when Γ becomes equal to unity. The criterion curves and the stellar data are plotted in the (log surface gravity, effective temperature) diagram. Most of the late B-type stars, except the supergiants, are stable against the radiation pressure. For early B stars, radiative instability sets in. The supergiant B may be identified with the *P Cygni* stars. For the hotter stars, with the effective temperatures above 30 000°, streaming-out of the atmosphere become a general trend, as is actually observed in *Of* and Wolf–Rayet stars. A.

523.877

7407. Contribution to the study of stellar atmospheres. I. The adiabatic gradient. A. MASANI. *Mem. Soc. Astron. Ital.*, **24**, *No.* 1, 15–30 (1953) *In Italian.*

The adiabatic gradient is calculated for a mixture of radiations and a chemical composition of hydrogen and helium in the same weight proportions; and for a mixture of radiations and pure hydrogen; according to electronic pressure and temperature varying in the field of the atmospheres of the early spectral type stars. A.

523.877

7408. The existence of a convective core at the centre of stars. P. LEDOUX. *C.R. Acad. Sci.* [*Paris*] **236**, 2381–3 (*June* 22, 1953) *In French.*

The possibility is examined that a molecular density-gradient, arising from proton-proton reaction, will develop in the central zone of a star; which, in certain defined circumstances, can inhibit central convection and so modify the subsequent evolution of the star.

D. R. BARBER

525.35

7409. A suggested explanation of the present value of the velocity of rotation of the Earth. E. R. R. HOLMBERG. *Monthly Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 325–30 (*Sept.*, 1952).

It is suggested that the coincidence of the period of rotation of the Earth and a natural period of vibration of the atmosphere is not fortuitous but due to the Earth being driven at a constant rate in synchronism with the vibration. An observation by Kelvin that the gravitational couple on the atmospheric tides accelerates the Earth's rotation is recalled, and the production of mechanical energy to balance the dissipation of the oceanic tides is discussed. The astronomical evidence supporting the current view that the rotation is being steadily retarded is reviewed and found to contain contradictions, and it is claimed that the high value of the angular momentum of the Earth-Moon orbit supports the hypothesis of equilibrium. A.

525.35

7410. Effect of exchanges of transportable [material] between atmosphere and globe, on the position of the instantaneous axis of rotation of the earth. On the fluctuations of sea-level, and of the velocity of rotation of the earth. F. H. VAN DEN DUNGEN, J. F. COX AND J. VAN MIEGHEM. *Bull. Acad. Roy. Belgique Cl. Sci.*, **39**, *No.* 1, 24–8; 29–34 (1953) *In French.*

From a consideration of the results of transporting large masses of air across the surface of the globe it is demonstrated that meridional winds can ex couple which will turn with the rotating globe, w effect will be to displace the terrestrial axis reference to the stars; and thus to cause an err the computed values of stellar declinations. A s of ocean-tide data reveals also a positive effect o terrestrial rotation of changes in the earth's mo of inertia due to periodic (seasonal) melting o principal glaciated regions on the surface of the g

D. R. BA

PHYSICS 53

53.081.6

7411. Physical similarity and dimensional analysis. W. J. DUNCAN. *London: Edward Arnold*, vii + 156 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 285 (*Sept.*, 1953).

53.083.91

7412. The indirect measurement of certain physical quantities by means of mechanical multipliers. M. FIORA. *Ann. Franç. Chronom.*, **7**, *No.* 3, 157–70 (1953) *In French.*

Certain physical quantities Q which increase with time t cannot be measured directly on a single instrument but are obtained by taking the product of the indications of two or more instruments. For example, if Q depends on two variable quantities $x = f(t)$ and $y = g(t)$ and $Q = \int_{t_1}^{t_2} xydt$, a counter can be used to give $\int_{t_1}^{t_2} xdt$, an apparatus to measure y at each instant and a multiplier to obtain Q. The characteristics of a mechanical multiplier are enumerated and various commercial forms already in use or proposed, including both cyclic and instantaneous types, are described and shown diagrammatically.

S. WEINTROUB

53.087 : 535.33.07

7413. Semi-automatic recording of wavelength data. G. K. WERNER. Letter in *J. Opt. Soc. Amer.*, **43**, 620–1 (*July*, 1953).

An instrument is described, with sketch, for recording spectrum line position measurements. The plate is viewed by a comparator geared to a digital converter which furnishes a six-figure setting punched on to an IBM card. A key punch machine allows other information on the line to be added to the card by hand operation.

S. T. HENDERSON

FUNDAMENTALS 530.1

530.12

7414. Conformal relativity. L. INGRAHAM. *Nuovo Cimento*, **9**, 886–926 (*Oct.*, 1952).

If one keeps angle but drops an invariant (four-dimensional) length from an essentially Einsteinian description of the world, one gets Conformal R tivity. (The invariance of angle is all that is requ by the "invariance of the light cone" for physi equivalent observers.) The Special Theory of C formal Relativity studies the conformal geom which replaces the Lorentz geometry of sp relativity, from the kinematical point of view, world free of force fields. The General Theory t a world with a curvilinear conformal geometry jected to the one condition of minimum "to curvature. The extremal equations describe f fields which comprise, along with the familiar gra tional and electromagnetic fields, several "meso The General Theory is thus a unified field the which, because it is modelled on Einsteinian relati is completely free from arbitrary elements. mathematical language allows interpretation in te of exclusively four-dimensional geometric notions.

53

7415. Spinor relativity. R. L. INGRAHAM. *Nu Cimento*, **10**, 27–42 (*Jan.*, 1953).

The pure-geometrical part of the paper ma various contributions to the theory of metric connection in spinspace. The physical part giv unified field theory, which aims to include the ma field, obtained by putting a simple (Einsteinian) c dition on the curvature of the spin connection u Of the resulting theory in particular it generalizes author's Conformal Relativity, that it admits conformal group as physical group, and that the the of matter so obtained is of Dirac form.

536

7416. Equations of motion and field equations five-dimensional unified relativity theory. R. INGARDEN. *Dokl. Akad. Nauk SSSR*, **88**, *No* 773–6 (1953) *In Russian.*

The points of view of (*a*) Einstein and In (matter associated with singularities in the field) (*b*) V. A. Fok (1939), who introduces explicitly energy momentum tensor, can be partly reconc by the formulation of a 5-dimensional relati theory (signature +, −, −, −, −) with an app priate condition on the energy momentum tens From this point of view the possibility of deduc the equations of motion from the field equations is be regarded as a postulate rather than as a conseque of the theory.

W. J. SWIATE

530.12

. **On the spatial rotation associated with a ntz cycle.** V. LALAN. **Observations on the pre- g communication.** R. GARNIER. *C.R. Acad.* [*Paris*] **236,** 2297–8, 2299 (*June* 15, 1953) *In ch.*

sequence of special Lorentz transformations $_2, \ldots S_n$, such that S_n denotes a frame at rest ive to S_1 involves in general a spatial rotation of . This rotation is discussed in terms of parallel sport in Riemannian space. Garnier relates the ussion to hyperbolic rotations. R. A. NEWING

530.12

. **The Lorentz transformations not forming, in ral, a "group." Physical significance of this erty.** A. METZ. *C.R. Acad. Sci.* [*Paris*] **237,** 1 (*July* 6, 1953) *In French.*

Lorentz transformation here means one which erves $x^2 + y^2 + z^2 - c^2t^2$, but is not a "spatial tion" (which conserves $x^2 + y^2 + z^2$ and leaves changed). The composition of these transforma- s is studied, and their significance in Kinematical utivity is discussed. L. S. GODDARD

530.12 : 523.841.2 : 535.22

. **Binary stars and the velocity of light.** P. MOON D. E. SPENCER. *J. Opt. Soc. Amer.*, **43,** 635–41 ., 1953).

e Sitter showed that if the velocity of light is tant with respect to the source, distant binaries exhibit certain peculiarities that have not been rved. This is usually regarded as proof of the lity of Einstein's second postulate of special tivity. But there are several ways of invalidating proof. One of the most promising ways—that of loying Riemannian space for light—is considered. a on visual binaries, spectroscopic binaries and heids are calculated for Euclidean space and for nannian space of constant positive curvature = 5 light years). The acceptance of Riemannian e allows us to reject Einstein's relativity and to all the ordinary ideas of time and all the ideas uclidean space out to a distance of a few light s. Astronomical space remains Euclidean for erial bodies, but light is considered to travel in nannian space. In this way the time required for t to reach us from the most distant stars is only ears. A.

530.12 : 530.145

. **The similarity theory of relativity and the c–Schrödinger theory of electrons. II.** B. HOFF- N. *Phys. Rev.*, **91,** 751–65 (*Aug.* 1, 1953).

or Pt I, see Abstr. 2170 (1953). The variational ciple given in the previous Pt is here modified tly in three stages. First the integral is made larity-invariant. Then a sign is changed so that nsistent signature for the various terms shall be ible. Finally, a numerical discrepancy that was d on making a detailed comparison with the lan theory of the variable gravitational constant is oved, so that the equations of the latter theory for ty space are obtained as a special case of the ent theory when all quantities except g_{ab} and ω et equal to zero. A.

530.12 : 531.51

7421. Gravitational motion. A. E. SCHEIDEGGER. *Rev. mod. Phys.*, **25,** 451–68 (*April*, 1953).

An exposition of the Einstein–Infeld–Hoffmann derivation of equations of motion from the field equations is followed by detailed application to the two-body problem. General methods of integration of differential equations of motion and the influence of co-ordinate conditions are considered, and the problem of gravitational radiation is discussed; this part of the paper is mainly concerned with results already published by Infeld and by the author.

R. A. NEWING

530.12 : 536.7

7422. Thermodynamics of a relativistic fluid. PHAM MAN QUAN. *C.R. Acad. Sci.* [*Paris*] **236,** 2299–301 (*June* 15, 1953) *In French.*

An attempt is made to generalize the energy-momentum tensor by the introduction of thermodynamic terms. Equations of conduction and conservation are derived. R. A. NEWING

530.145

7423. Remarks on the time-singularity, the use of a homogeneous quantum formalism and on the uncertainty relation between time and "energy." P. WILKER AND A. MERCIER. *Helv. phys. Acta*, **26,** *No.* 3–4, 181–90 (1953) *In French.*

In the ordinary canonical formalism (non-homogeneous) the time plays a singular part. This is avoided by the introduction of a homogeneous process. Two procedures are explained and illustrated by discussion of the free particle and a potential, $-V(x)$. L. S. GODDARD

530.145

7424. The relation of quantum theory to the theory of gravitation and electromagnetism and an application to the theory of the electron. H. T. FLINT AND E. M. WILLIAMSON. *Z. Phys.*, **135,** *No.* 3, 260–9 (1953) *In German.*

A review of Flint's 5-dimensional theory in which a matrix line element is introduced. R. A. NEWING

530.145

7425. Quantum spectrum of masses, lengths and time. R. REULOS. Letter in *J. Phys. Radium*, **14,** 346–7 (*May*); Erratum, 430 (*June*, 1953) *In French.*

Supposing that the product of mass with an associated fundamental length is a multiple of $\hbar/2$, a spectrum of fundamental masses and frequencies is obtained. R. H. DALITZ

530.145

7426. A simple model of two interacting fields. A. LOINGER. *Nuovo Cimento*, **9,** 1080–6 (*Nov.*, 1952) *In Italian.*

A model consisting of two strings elastically coupled point to point and transversally vibrating in the same plane is used, through the conventional quantization method of Heisenberg–Pauli, to investigate the divergencies which occur in field theories. Particularly it is shown that an "orthogonality theorem," proved by van Hove [Abstr. 4125 (1952)] for a scalar boron field in scalar interaction with several sources, is not true for this model. It is concluded that this theorem does not exclusively depend

on the fact that a field is a system with infinite degrees of freedom. A.

530.145

7427. On a regular field theory. J. RAYSKI. *Nuovo Cimento*, **10**, 1–26 (*Jan.*, 1953).

A regular field theory is constructed in a finite space-time domain Ω restricted by two space-like hypersurfaces. The field equations are integral equations with regular kernels. The solutions are integer functions of the coupling parameter. Integral conservation laws are inferred. In order to secure the correspondence with the traditional field theory the form factor (introduced to regularize the kernels) must depend on the domain Ω. The integral field equations are quantized directly, without any reference to the canonical formalism. The Schrödinger–Tomonaga equation does not exist, but the formalism yields unambiguous results concerning the probability amplitudes connecting the measurements on the two hypersurfaces. The author represents the opinion that field quantization has nothing to do with the convergence difficulties. They disappear in the case of a finite domain and of regular kernels. A.

530.145

7428. On the problem of the transformation of variables in the theory of distribution. II. S. ALBERTONI AND M. CUGIANI. *Nuovo Cimento*, **10**, 157–73 (*Feb.*, 1953) *In Italian.*

For Pt I, see Abstr. 2411 (1952). The aim of this work is the study of the variables transformation in the distribution theory in the case of several variables. The study is applied to prove some formulae concerning Dirac's singular functions, frequently used in quantum theory. A.

530.145 : 534.112

Canonical field theory—a prototype example. *See Abstr.* 7520

530.145

7429. Renormalization in divergent series. A. PETERMANN. *Helv. phys. Acta*, **26**, *No.* 3–4, 291–9 (1953) *In French.*

Subtraction procedure is applied to divergent series arising from perturbation expansions of purely scalar two-fields theories. It is first shown that mass renormalization cannot give rise to a conditionally convergent series for all values of external momenta. Further, the charge renormalization is discussed, leading again to a generally divergent series; however, some ambiguities remain in the definition of parts which are to be considered as charge renormalization terms, and thus this subtraction procedure loses its well-defined character. A.

530.145

7430. The theory of quantized fields. II. J. SCHWINGER. *Phys. Rev.*, **91**, 713–28 (*Aug.* 1, 1953).

For Pt I, see Abstr. 6731 (1952). The arguments leading to the formulation of the action principle for a general field are presented. In association with the complete reduction of all numerical matrices into symmetrical and antisymmetrical parts, the general field is decomposed into two sets, which are identified with Bose–Einstein and Fermi–Dirac fields. The spin restriction on the two kinds of fields is infi from the time reflection invariance require The consistency of the theory is verified in terms criterion involving the various generators o finitesimal transformations. Following a discu of charged fields, the electromagnetic field is i duced to satisfy the postulate of general g invariance. As an aspect of the latter, it is recog that the electromagnetic field and charged field not kinematically independent. After a discussi the field strength commutation relations, the i pendent dynamical variables of the electromag field are exhibited in terms of a special gauge.

53C

7431. The theory of quantized fields. III. SCHWINGER. *Phys. Rev.*, **91**, 728–40 (*Aug.* 1, 1953

The electromagnetic field as perturbed by a scribed current is discussed. All quantities physical interest in various situations, eigenva eigenfunctions and transition probabilities, derived from a general transformation function w is expressed in a non-Hermitian representation. problems treated are: the determination of energy-momentum eigenvalues and eigenfunctions the isolated electromagnetic field, and the en eigenvalues and eigenfunctions for the field pertur by a time-independent current; the evaluation transition probabilities and photon number expe tion values for a time-dependent current that dep from zero only within a finite time interval, and f time-dependent current that assumes non-vanish time-independent values initially and finally. results are applied in a discussion of the infra catastrophe and of the adiabatic theorem. It is sho how the latter can be exploited to give a uniform for lation for all problems requiring the evaluation transition probabilities or eigenvalue displacements

530.

7432. The correspondence between classical quantum electrodynamics. G. MORPURGO. *Nu Cimento*, **9**, 808–17 (*Sept.*, 1952) *In Italian.*

It is shown that in the non-relativistic case anc dipole approximation a complete correspond exists between the classical Dirac–Eliezer equation a point electron and the equation which, in quant electrodynamics, governs the variation with time the expectation value of the position of the electr For an harmonic oscillator the correspondence is close that the expectation value of the position of oscillator satisfies the Dirac–Eliezer equation exac As a consequence it results that, at least for harmonic oscillator, the introduction of Planck's co stant cannot solve the difficulties of the physical a non-physical solutions of the Dirac–Eliezer equati Moreover, the variation with time of the expectati value referred to is an example of resolution of problem of quantum electrodynamics complet independent from perturbation-theory.

530.1

7433. The current density in quantum electr dynamics. H. C. CORBEN. *Nuovo Cimento*, **9**, 1071 (*Nov.*, 1952).

The formulation of field theory given previous [Abstr. 7440 (1953)] suggests an alternative expressi

ne current density in quantum electrodynamics. expression is gauge-invariant and conserved and s from the usual current density by the divergence tensor which vanishes in the absence of a field. esponding to this current is a new electro- etic field, which differs from the old only in the nce of particles. The energy density of this new then contains the interaction energy of the etic moments of the particles with the magnetic together with some terms which are small for ic electrons. A.

530.145

On the introduction of de Broglie's theory of hoton in Schwinger's quantum electrodynamics. OSTA DE BEAUREGARD. *C.R. Acad. Sci.* [*Paris*] 2215–17 (*June* 8, 1953) *In French.*

530.145

The energy-momentum tensor of the electro- etic field inside matter. N. L. BALAZS. *Phys.* **91,** 408–25 (*July* 15, 1953).

o different energy-momentum tensors have been osed to describe the electromagnetic field inside r. Abraham suggested a symmetric tensor while owski's tensor is non-symmetric. With the aid hought-experiment it is shown here that only the netric tensor satisfies the momentum conservation entre-of-mass theorems simultaneously. A.

530.145 : 538.3

A variational formulation of the multi-stream odynamic field equations. P. N. BUTCHER. *Mag.*, **44,** 971–9 (*Sept.*, 1953).

non-relativistic approximation to Dirac's new tional formulation of the single-stream electro- mic field equations is presented using 3-vector ion and m.k.s. units throughout. The Hamilton– oi theory of a rotational space charge stream is oped. The variational formulation is generalized e multi-stream case—both for a finite number non-denumerably infinite number of streams. A.

530.145

On the solution of the equation of electron ne field of electromagnetic radiation. N. D. UPTA. *Bull. Calcutta Math. Soc.*, **44,** 132–6 ., 1952).

rac's method of "redundant variables" is applied e Dirac equation for an electron in a quantized tion field. For radiation incident from all tions, the complete solution given is $\psi(p) = -2\pi i(p \cdot x) - iS\hbar\}\psi'$, where S and ψ' are in form. For case of radiation incident along a ular direction, the series for S and ψ' terminate a few terms. G. FIELD

530.145

Non-local interactions — Compton effect ple. R. ASCOLI. *Nuovo Cimento*, **9,** 757–63 ., 1952) *In Italian.*

velops the method proposed by Wataghin r. 9265 (1951)] to introduce the idea of non-local ictions in field theory. The invariants have been mined on which the cut-off factors deriving from pplication of the method depend. Expressions have been deduced to calculate such invariants. As an example the method has been applied to Compton effect. A.

530.145

7439. On a solution of equations of the diffusion type; applications to the theory of renormalization. A. VISCONTI. *C.R. Acad. Sci.* [*Paris*] **236,** 2489–91 (*June* 29, 1953) *In French.*

Fredholm's method for integral equations is adapted to the solution of the operational equation $U = U_0 + \lambda\mathcal{K}U$, where U_0 and $\mathcal{K}$ are known operators. Application to renormalization procedure is indicated. See also Abstr. 4615 (1953).

R. A. NEWING

530.145

7440. A reformulation of field theory. H. C. CORBEN. *Nuovo Cimento*, **9,** 580–96 (*July*, 1952).

An alternative formulation is given for the quantum theory of fields in which the charge on a particle is introduced as an operator rather than as a number. In addition to the advantage of mathematical simplicity, this formulation allows the fundamental properties of charge quantization and charge conservation to be deduced from the one hypothesis introduced to replace that of gauge invariance of the first kind. Systems of particles of different mass and charge may be treated more elegantly by this method, which is identical with the usual one for particles of spin zero, but which leads to a generalized Dirac equation which could be applied, for instance, to a mixed electron and neutrino field. This equation is very simply expressible in terms of modified field-dependent Dirac operators, and leads to oscillations of the specific charge of a particle analogous to the Zitterbewegung. A.

530.145

7441. A new wave equation for a particle of spin $\frac{1}{2}$. P. CALDIROLA AND P. GULMANELLI. *Nuovo Cimento*, **9,** 834–45 (*Sept.*, 1952) *In Italian.*

The results obtained by a new wave equation for a spins $\frac{1}{2}$ particle, recently proposed by Corben in a unitary field theory (preceding abstract), are compared with those arising from the ordinary Dirac equation. Particularly the problem of the fine structure for hydrogen-like atomic levels is considered and the relation between the magnetic moment and the nature of the particle mass is examined. A.

530.145

7442. On the algorithm of Dirac spurs. E. R. CAIANIELLO AND S. FUBINI. *Nuovo Cimento*, **9,** 1218–26 (*Dec.*, 1952).

The spur of the product of any number of Dirac matrices is shown to be the square root of a determinant. It can be evaluated directly, however, by means of rules as simple as those of determinant theory. When the number of matrices occurring in the product is $\geqslant 12$, further considerations show that many terms of the expansion sum up to give zero total contribution. A final formula is given which takes all such reductions into account. The appendix contains rules for summing over pairs of γ^μ which bracket products of Dirac matrices. A.

530.145

7443. Derivation of mathematically equivalent tensor equations from Dirac's equations for the wave fields of elementary particles of non-zero mass and arbitrary integral spin. H. DONNERT. *Acta phys. Austriaca*, **7**, *No.* 2, 181–97 (1953) *In German.*

The connection between certain spinors and tensors is presented in detail and applied to the equations of Dirac. W. A. HEPNER

530.145

7444. On the question of the connection between the method of regularization and the theory of particles with arbitrary spin. V. I. KARPMAN. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 257–60 (1953) *In Russian.*

It is shown that, despite apparent similarities in the spectrum of masses used in the regularization procedure and that of particles with arbitrary spin, the regularization equations are not automatically satisfied by the latter. W. J. SWIATECKI

530.145

7445. Note on the connection between spin and statistics in the theory of elementary particles. D. RIVIER. *Helv. phys. Acta*, **26**, *No.* 3–4, 300–6 (1953) *In French.*

It is shown that the postulates under which Pauli showed that particles with half spin obey Fermi–Dirac statistics, and particles with integral spin Bose–Einstein statistics, may, when the metrics of the Hilbert space of the quantum states is positive definite, be replaced by the postulate that the operators corresponding in quantum theory to the classical constant of motions must form in the Hilbert space a representation of the infinitesimal operators constituting the continuous groups of transformations leaving invariant the classical equations of motion. The connection between spin and statistics is thus a direct consequence of the relativistic invariance of field theories. L. PINCHERLE

530.145

7446. Non-localized interactions in the quantum theory of elementary particles and fields. H. L. JORDAN. *Z. Naturforsch.*, **8a**, 341–52 (*June*, 1953) *In German.*

It is shown how a convergent theory with non-localized interaction can be described by a more general definition of the product of two fields with the help of a general invariant functional transformation G containing a universal length. A special form of G is related to Heisenberg's wave packets of minimal uncertainty and to certain regulators and self-reciprocal functions. The field equations for the new functions are similar to those arising from Bloch's formalism [Abstr. 2197 (1953)]; they are obtained from the old field equations by transformation with G, but using the original initial and boundary conditions for the new functions. Using the Lagrangian formalism, the usual conservation laws are shown to hold for the transformed quantities. The formalism is to be tested in the case of meson theory by the method used by Kristensen and Møller [Abstr. 2196 (1953)]. W. A. HEPNER

530.145

7447. On the calculation of the scattering of particles of spin $\hbar/2$ by a pseudoscalar Coulomb potential. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **236**, 2 (*June* 15, 1953) *In French.*

Formulae for the scattering amplitudes for a particle in an $\hbar\alpha_1\alpha_2\alpha_3\alpha_4\beta/r$ potential are de (α-Dirac matrices). W. J. SWIA

53

7448. Structure and mass spectrum of elem particles. I. General considerations. II. Osc model. H. YUKAWA. Letters in *Phys. Rev* 415–16 (*July* 15, 1953).

With sufficiently general non-local fields [3762 (1950), 2367 (1951)] the field equations c reduced to those of Kristensen and Møller for local interaction, but the form function contain the whole spectrum of internal (mass) eigenfunc Using Born's self-reciprocal eigenfunctions (P a resulting complication of the question of vergence of the total S-matrix is pointed out implications of two possible ways of removin infinite degeneracy of the eigenvalues of the ma considered. W. A. HE

53

7449. The non-adiabatic method with a n pseudo-scalar meson field. D. BARONCINI. *Cimento*, **9**, 642–58 (*Aug.*, 1952).

Dancoff's non-adiabatic procedure for the nucleon system interacting with a meson fie applied to the neutral pseudo-scalar meson taking into account both types of couplings pseudo-scalar and the pseudo-vector. The proc is limited to the 2nd order of the coupling cons Using the Hamiltonian containing the d interaction term, the Schrödinger equation of m contains interaction potentials, one of which i duces into the equation a high singularity. reason is that the term arising from the d interaction Hamiltonian does not cancel comp with the so-called contact-term, which arises fro nucleon-meson interaction Hamiltonian, as is the in the adiabatic procedure. If the direct-intera Hamiltonian is neglected from the beginning, Schrödinger equation contains a singular pote which corresponds to the contact-term of the adia approximation. This potential behaves, howeve the corresponding potential in the previous case, not as a δ-function, as is the case in the adia procedure. The remaining interaction poten which are the same in the two cases, are less sing than the potentials in the adiabatic procedure. I non-relativistic limit, the interaction functions lea the same functions given by the conventional turbation procedure.

530

7450. Contributions to the numerical treatme the Schrödinger equation for the Yukawa pote K. V. LAURIKAINEN AND E. K. EURANTO. *Z. an Math. Phys.*, **4**, *No.* 2, 155–8 (1953) *In German.*

For bound states with $l = 1$ and 2 in a Yuk potential, approximate eigen-states are found variation methods using trial functions generali those previously used for $l = 0$ [Abstr. 8448 (19 The three lowest eigenvalues of the potential stre for given binding energy ε are tabulated for l 1 and 2, and an asymptotic expansion for

t eigenvalue, valid for all l and for large ε, en. R. H. DALITZ

530.145

On the universal Fermi-type interaction. III. . CAIANIELLO. *Nuovo Cimento*, **10**, 43–53 (*Jan.*,

r Pt II, see Abstr. 2420 (1952). An analysis is of the symmetry requirements which can be sed upon a linear combination of the odd lings used in Pts I and II to study the possibility universal Fermi-type interaction. A unique ion results if one takes into account some well- lished experimental facts and makes the assump- that the universal interaction has the same form ll processes. The remaining ambiguity between different modes still allowed by this criterion to various processes can be removed by further ning that some rule exists to discriminate among . Two alternatives then result which lead to ent shapes of the muon spectrum. A final ion depends therefore upon the precise knowledge his spectrum. Both alternatives compare rably for β-decay with all the experimental nce thus far. A.

530.145

Energy in the nuclear field. E. M. WILLIAM- *Nuovo Cimento*, **10**, 113–26 (*Feb.*, 1953).

e various types of nuclear field may be described nsors of suitable rank in a 5-dimensional con- m which satisfy field equations whose form is sted by electromagnetic theory. The 5-dimen- l notation suggests the adoption of a generalized y tensor which is found to consist of terms ly introduced separately as field energy and action energy respectively. It follows from the ar field equations that the total energy is now . An alternative expression for the interaction y is obtained from the fundamental equation e nucleon in the presence of the nuclear field. contains terms involving the field tensors which ate an additional amount of energy. Comparison is expression with that part of the total energy n is considered to be interaction energy identifies olarization tensors associated with the nucleon. interaction energies are calculated for the two- on problem and found to be of the usually ted type. The new suggestion, however, is that nfinite terms which arise are balanced by corre- ding terms in the field energy. Although this reviously been pointed out in a simple case the nt paper shows that this property is shared by ypes of nuclear field. The results are finally ssed in the usual 4-dimensional notation but -dimensional approach introduces a coherence he treatment of the problem, as Klein has shown es in other branches of physics. A.

530.145

On the calculus of effective cross-sections of mb scattering between particles of spin 0, $\hbar/2$

G. PETIAU. *J. Phys. Radium*, **14**, 137–44 *ch*, 1953) *In French.*

e introduction of a simple representation for the ns of irreducible matrices of the theory of spin 0 and 1 particles. Application to the covariant calculus of cross-sections for electromagnetic Coulomb scattering or mesonic scattering (vector, scalar or ps. scalar) between 2 particles of spin 0, $\frac{1}{2}$ or 1. W. J. SWIATECKI

530.145

7454. Remarks on the Born–Oppenheimer approximation for the treatment of collision problems. K. WILDERMUTH. *Z. Naturforsch.*, **8a**, 284–92 (*May*, 1953) *In German.*

An investigation into the nature of Oppenheimer's approximational procedure with the aid of a simple example. It is noted that the approximation neglects the indistinguishability of similar particles. Amendments of the method, which would allow for this indistinguishability, are considered. P. T. LANDSBERG

530.145

7455. Two-particle potential from the Bethe–Salpeter equation. W. MACKE. Letter in *Phys. Rev.*, **91**, 195 (*July* 1, 1953).

Rules for the calculation of the interaction operator for all Feynman graphs and orders, and brief comparison with the results of the method of Tamm and Dancoff. W. A. HEPNER

530.145

7456. The formal theory of scattering. M. GELL-MANN AND M. L. GOLDBERGER. *Phys. Rev.*, **91**, 398–408 (*July* 15, 1953).

The theory of scattering is developed from first principles with strict attention to the question of the preparation of the state vector of the system appropriate to a description of scattering. The connection between the present formulation and the more conventional interaction representation and S-matrix presentations is traced. The wave matrix of Møller is introduced and the existence of bound states is discussed in connection with it. A number of applications to rather involved processes are discussed. Finally, the problem of self-energies in field theoretic scattering calculations is treated. A.

530.145

7457. Spin-orbit coupling in pseudoscalar meson theory. L. DRESNER. Letter in *Phys. Rev.*, **91**, 201 (*July* 15, 1953).

Rules and results of calculation of spin-orbit corrections corresponding to some typical Feynman diagrams for two-, three-, and four-nucleon potentials. The resulting level splittings are too small for the requirements of the shell model; moreover, they cast doubt on the convergence of the procedure. W. A. HEPNER

530.145

7458. Convergence of the adiabatic nuclear potential. A. KLEIN. *Phys. Rev.*, **91**, 740–8 (*Aug.* 1, 1953).

The leading term of the potential of order $4n$ (n an arbitrary integer) of the pseudoscalar theory with pseudoscalar coupling is computed by a method which takes advantage of the special pair character of this term. It is shown that the coefficients increase with n as $n!\,(n-1)!$; thus, despite the decreasing ranges, the unrenormalized potentials grow enormously with n, even in the nonrelativistic domain.

The breakdown of the expansion in μ/M for a given order is also indicated. A weakness of the discussion is that it does not include radiative corrections. A.

530.145

7459. Note on the low-energy properties of the nucleon-nucleon interaction. R. JASTROW. *Phys. Rev.*, **91**, 749–50 (*Aug.* 1, 1953).

A previously proposed model for the nucleon–nucleon interaction [Abstr. 3331 (1951)] consists of the potential yielded by the symmetrical pseudoscalar theory with pseudoscalar coupling, calculated to the fourth order in the coupling constant and cut off by a hard sphere repulsion. Further calculations relating to the low-energy properties of this potential have been carried out in which the effect of a variation in the magnitude of the fourth-order term is considered. The computed low-energy constants are found to be insensitive to this variation. A.

530.145

7460. Poles of the S matrix for resonance reactions. M. MOSHINSKY. *Phys. Rev.*, **91**, 984–5 (*Aug.* 15, 1953).

In this note the restrictions on the position of the poles of the S matrix for resonance reactions are obtained, that are a consequence of the definition of the S in terms of Wigner's R matrix. A.

530.145

7461. The classical equations of motion of point particles. II. P. HAVAS. *Phys. Rev.*, **91**, 997–1010 (*Aug.* 15, 1953).

In Pt I [Abstr. 7049 (1952)] the problem of the relation of field theory and the theory of action at a distance was investigated for the neutral vector and scalar meson theories. The work is here extended to the charge-symmetrical meson theory. First the equations of motion of particles interacting through vector meson fields are found for half-retarded, half-advanced interaction, using the field-theoretical methods developed for retarded interaction; equations for both cases are given for particles interacting through scalar meson fields. These equations contain integrals over the past and entire motion in the retarded and symmetric case, respectively. These are inadmissible from the point of view of action at a distance, and new equations are postulated. Variational principles are developed for these equations, and energy-momentum tensors and charge-current vectors guaranteeing detailed conservation laws are defined. The application of the Wheeler-Feynman method to the equations of both theories is discussed. Conclusions analogous to those found in the neutral case are obtained. A.

530.145 : 537.533.74

7462. Evaluation of integrals in the theory of atomic scattering of electrons. E. CORINALDESI AND L. TRAINOR. *Nuovo Cimento*, **9**, 940–5 (*Oct.*, 1952) *In Italian.*

Describes the application of methods recently developed in field theory. A.

530.145 : 539.18

Production of mesons and the localization of field energy. *See Abstr.* 7960

55

7463. The meaning of wave functions. A ALEKSANDROV. *Dokl. Akad. Nauk SSSR*, **85**, 291–4 (1952) *In Russian.*

Bohr's concept that wave functions are r records of information obtained about el states, as well as the "ensemble" concept, are re as ascribing more importance to human theo constructs to explain nature, than to the ph realities behind them. The case for the view of functions as descriptions of the objective state electron is argued, and the meaning of the con of "measurement," "physical magnitude" probability is discussed. R. C. MU

52

7464. A remark on the uniqueness of the pot determined from the asymptotic phase. B. HOLM *Nuovo Cimento*, **9**, 597–604 (*July*, 1952).

It is shown that the impossibility of determ the potential between two particles from the as totic phases when there exist also bound stat due to the fact that it is not possible to exten orthogonality relations given by Fröberg (1948 Hylleraas (1948) to the discrete eigenfunctions. expression in terms of these functions is given fc difference between two phase equivalent pote with the same energy spectrum. Finally (in the when only one bound state exists) an explicit for is given for constructing this difference if one sp potential and its corresponding eigenfunctio known.

53

7465. Representations of the Galilei group. INÖNÜ AND E. P. WIGNER. *Nuovo Cimento*, **9**, 70 (*Aug.*, 1952).

While the transition to a moving coordinate sy $(x \to x + vt,\ t \to t)$ commutes in classical mech with displacements $(x \to x + a,\ t \to t)$, the c sponding operations in Schrödinger's non-relati wave mechanics do not commute. In fact, the operations, taken in different orders, differ factor $\exp[imv \cdot a/\hbar]$. The present article cons the possibility of a nonrelativistic wave mechani which the transformations of the wave functions the same commutation relations as the transforma themselves. It shows that in such a mecha position and momentum operators can exist on it is reducible, i.e. only if the set of all states ca decomposed into subsets which are thems invariant with respect to all permissible transfo tions of classical mechanics (rotations, displacem proper Galilei transformations).

530

7466. The Dyson–Feynman operator $U(t)$. FUBINI. *Nuovo Cimento*, **9**, 846–51 (*Sept.*, 1952 *Italian.*

This is shown to diagonalize the total Hamilto independently from any perturbation-theore treatment. The fact that, in general, $U(t)$ is uni only in a restricted sense is used to extend this s to the case in which the Hamiltonian admits discrete eigenvalues.

530.145

. Calculation of integrals arising for certain ximate forms of the wave function. C. VROELANT. *Acad. Sci.* [*Paris*] **236,** 2504–6 (*June* 29, 1953) *In ch.*

ie approximate wave functions considered are ie form $\Sigma_k f_k(\ldots x_i \ldots) \exp[-g_k(\ldots x_i \ldots)]$ e the f_k are polynomials and the g_k polynomials ie second degree for which the coefficients of z_i^2 and z_i^2 are the same, and of x_iy_i, y_iz_i, and z_ix_i ero. The only difficult integrals arising are the and $1/r_{Ai}$ types, where i,j, refer to electrons and a nucleus. A suitable change of axes transforms irst into the same form as the second. In transing now to polar coordinates, integration over θ ϕ is straightforward, and that over r can be essed in terms of the error function.

H. H. GREENWOOD

530.145

. The causal interpretation of quantum anics. S. T. EPSTEIN. *Phys. Rev.*, **91,** 985 . 15, 1953).

connection with the discussion given in a ious note, a classical Hamilton–Jacobi equation ciated with the Schrödinger function in momenspace is derived. Certain "extra" terms in this tion are shown to be of quantum-mechanical n. A.

530.145 : 535.1

. Motion of a particle across a potential jump. . KOTHARI. Note in *Amer. J. Phys.*, **21,** 468–9 ., 1953).

ie close analogy between the wave-mechanical optical problem is considered. W. A. HEPNER

530.162

). Application of second quantization methods to classical statistical mechanics. M. SCHÖNBERG. *vo Cimento*, **9,** 1139–82 (*Dec.*, 1952).

lethods similar to those of second quantization applied to the Liouville equation of classical stical mechanics. An equation similar to the rödinger equation of a quantized field is given. shown that the interpretation rules of the quantal of the field formalism lead to the rules of classical istical mechanics, the particles being treated as stinguishable. The application of the Fock tment of second quantization leads to the introion of wave functions in phase space, the probay density of classical statistical mechanics being square of the absolute value of the wave function hase space. The choice of the sign in the comation rules of the field operators leads to symrical or anti-symmetrical wave functions in phase e. To each kind of symmetry corresponds a rent statistics, Bose or Fermi, as in quantum ry. The Boltzmann statistics corresponds to se space wave functions without symmetry conns. The wave functionals for the states with particles of the fields in phase space are analogous hose of the quantized fields of quantum theory. A.

530.162

1. Relation between time averages and ensemble ages in the statistical dynamics of continuous media. C. ECKART. *Phys. Rev.*, **91,** 784–90 (*Aug.* 15, 1953).

The method of correlations, which has been widely used in the theory of turbulence, is applied to the case of a field that satisfies linear equations. It is found that most of the difficulties encountered in the theory of turbulence disappear when the equations are linear and that a number of general results can be obtained. In particular, it is possible to use an analogue of Gibbs' procedure of replacing a time average by an ensemble average. The mathematical foundations of this procedure are discussed and shown to be considerably different from those for dynamical systems with a finite number of degrees of freedom, to which the method is usually applied. In particular, it is shown that it can be applied to dissipative fields excited by a randomly varying force. Three examples are treated in some detail: statistically uniform but nonisotropic fields; statistically nonuniform, dissipative fields excited by a random force; and the scattering of monochromatic radiation by inhomogeneities of the refractive index. The method of ensembles as applied to these problems, appears to have a mathematical foundation that is rather simpler than in other cases that have been considered in the past, but several basic and unsolved problems are mentioned. A.

530.162 : 536.7

7472. The effect of the [type of] statistics upon Maxwell's demon. N. L. BALAZS. *C.R. Acad. Sci,* [*Paris*] **236,** 2385–6 (*June* 22, 1953) *In French.*

It is pointed out that the restrictions, due to the uncertainty principle, upon the action of Maxwell's demon apply in the case of Bose–Einstein statistics but not in the case of Fermi–Dirac statistics. See also Abstr. 5308 (1953). E. H. SONDHEIMER

530.162 : 539.133

7473. Statistical mechanics of interacting dipoles. J. A. BARKER. *Proc. Roy. Soc. A,* **219,** 367–72 (*Sept.* 22, 1953).

The electrostatic energy of a system of molecules with permanent and induced dipole moments is calculated as a power series in the polarizabilities. The successive terms of the series refer to interactions of 2, 3, 4, . . . molecules. The first and second moments of the electrostatic energy are calculated to the first order in the polarizability, and used to give approximate expressions for the contribution of electrostatic forces to the free energy of polar liquids and solutions. The results are compared with corresponding results calculated to zero order in polarizability by Pople (1952–53). The semi-macroscopic approach of Martin (1937) and of Bonnor (1951) is examined, and shown to contain inconsistencies, which are removed by a slightly different approach. A.

530.17 : 621.317.729 : 621.392 : 621.3.012.8

7474. Electrical analogues. G. LIEBMANN. *Brit. J. appl. Phys.*, **4,** 193–200 (*July*, 1953).

The idea of the analogue representation of physical problems is discussed. The principles and operating techniques of the conducting paper, the electrolytic tank, the resistance-network and networks using resistive and reactive components are described and illustrated by a number of applications from various

fields of physics and engineering. A table compares the various types of analogue. 34 refs. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.222

7475. The tension in strings wrapped slantwise round cylinders. C. MACK. *Brit. J. appl. Phys.*, **4**, 145-7 (*May*, 1953).

The relations between the tension, normal reaction, coefficient of friction and certain angles involved, are found for a string wrapped slantwise round a cylinder: (i) when moving along a stationary path, friction thus being tangential to this path, and (ii) moving parallel to the cylinder axis, the relative configuration of the string remaining unchanged so that friction is parallel to the axis. In both cases the cylinder is of general cross-section. For certain cross-sections (e.g. circles) it is possible to obtain formulae completely specifying the curves adopted by the string. A.

531.43

7476. Coulomb friction with several blocks. J. S. THOMSEN. *Amer. J. Phys.*, **21**, 446–52 (*Sept.*, 1953).

Considers the problem of finding the initial accelerations of a number of blocks piled on top of each other with a given set of applied forces. Coulomb friction is assumed at all surfaces. The first section solves a numerical example of the two-block problem. Next, a general solution for the case of two blocks is obtained and presented graphically somewhat like a phase diagram. Finally, a method for solving the general case is given. A.

MECHANICAL MEASUREMENTS 531.7

531.7 : 53.08

7477. Metrology and the classification of measuring apparatus. A. MOLES. *Ann. Telecomm.*, **8**, 250–3 (*July*, 1953) *In French.*

The precise function of measuring apparatus as transducers of information is recalled and discussed. The distinction between recording and measuring is emphasized, and the information obtained by Fourier and similar analyses of records is briefly discussed. It is shown that the field of measuring apparatus is limited and in the physical domain is defined by three factors, the scales of frequency f_{max}/f_{min}, amplitude A_{max}/A_{min}, and precision ω. By means of a three-dimensional diagram [diagramme d'équarissage] with co-ordinates $\log A$, $\log f$ and ω the various instruments are classified according to their particular technical field and usefulness. S. WEINTROUB

531.714

7478. Measuring changes in length to one part in a million. G. R. GOHN. *Bell Lab. Record*, **31**, 201–4 (*June*, 1953).

A new extensometer designed for creep measurements on the lead sheaths of cables where the stresses are small and creep rate correspondingly slow. It combines an Arnold extensometer with a 10 :-1 lever system to give amplification of the movemen gauge mark on the free end of the lever, w observed with a travelling microscope. An ac of 1·2 microinches is possible under constan perature conditions. E. L

MECHANICS OF FLUIDS 532

532.12 : 5

Molecular sound velocity and molecular r pressibility of liquid mixtures. *See Abstr.* 7526

53

7479. Tensile strength of liquid nitrogen. MISENER AND F. T. HEDGCOCK. Letter in [*London*] **171**, 835–6 (*May* 9, 1953).

This is found to be 3·5 atmospheres, maximu the bellows method. It appears that no app relation exists between temperature and ob tensile strength. R. H. I

5

7480. Comment on the temperature dependen the viscosity of liquids. A. K. DOOLITTLE. Let *J. appl. Phys.*, **24**, 1067 (*Aug.*, 1953).

An η–T relationship put forward by the a [Abstr. 7587 (1951)] has been criticized by Gut and Simmons [Abstr. 8710 (1952)] who employe Gaussian criterion of fit to show that the pr author's formula is not as good as the simpler equ $\ln \eta = A + B/(T + C)$. Supporting this more plicated equation the author points out that Gaussian criterion does not apply. T. C.

53

7481. Further note on the temperature depend of the viscosity of liquids. F. GUTMANN AND L. SIMMONS. Letter in *J. appl. Phys.*, **24**, 1067–8 (*A* 1953).

Further statistical argument is put forwar substantiate the author's original criticism. preceding abstract. T. C. 1

532.13 : 539

7482. On the relation between dynamic viscosity rigidity. A. A. K. IBRAHIM. Letter in *J. ch Phys.*, **21**, 1422 (*Aug.*, 1953).

The analysis of the curves obtained by Marko *et al.* [Abstr. 8510 (1952)] yields the following relati ships for the viscoelastic liquid: (1) $N/\eta = mn$, a frequency range 0–60 c/s, and (2) $N/\eta = m'(n -$ for frequencies above 60 c/s, where N is the dyna rigidity, η the dynamic viscosity, n the frequency harmonic oscillations, and m, m', and C are c stants, m' being equal to $1 \cdot 5m$. It has been est lished that the second equation satisfies the exp mental values obtained with a solid over an n ra of 10–100 c/s. F. LACHM

532.137 : 621.317.39 : 621.317.7

7483. An electromagnetic torquemeter for use viscometry. C. A. R. PEARCE. *J. sci. Instrum.*, 232–6 (*July*, 1953).

An instrument is described which measures t torque exerted on the cup of a coni-cylindrical visc meter by balancing it against the action of a c

ıg an electric current in a magnetic field. A ystem incorporating a novel form of mechanical- :al transducer automatically adjusts the coil t. The measurement depends only on the magnetic constant of the instrument which has determined with an accuracy better than ⅛ and should remain unaltered indefinitely. easured torque is this constant multiplied by the coil current. In addition to measuring the the instrument can be arranged to control the ieter speed, and therefore the rate of shear, so maintain the shearing stress in the oil under nation at a predetermined value. Design details e results obtained with castor oil and with an ing non-Newtonian properties are included. A.

532.14 : 532.73 : 541.133 : 621.317.79

An instrument for the measurement of the of aqueous ionic solutions. C. F. McCourt. *Instrum.*, **30**, 241–4 (*July*, 1953).

escription is given of the theory and operation of trument designed primarily for the assessment ıe density in the range 1·04 to 1·08 g/ml. The d employed is one in which the actual measure- depends on the electrical conductivity of the n, and this measurement is achieved without e of immersed electrodes. The apparatus is ed with means of day-to-day standardization t internal standards, and of rendering its g immune to changes of the brine temperature he whole instrument range. The basis of the d follows the lines of the work of Blake [Abstr. 1947)]. The accuracy is such as to provide correct to 1 part in 1000. A.

532.51 : 536.25 : 551.513

The forced flow of a rotating viscous liquid is heated from below. T. V. Davies. *Phil. A*, **246** (*No.* 907) 81–112 (1953).

quid is contained in a cylindrical vessel and is t to heating on the horizontal base of the vessel. roblem of the forced flow arising from the g has been investigated in the case when the g function is symmetrically arranged about the l axis. It is found that the relative forced flow to become zonal in character when the vessel at a sufficiently high angular velocity. This e zonal motion is principally in the direction of ıation except near the outer portion of the fluid it is in the opposite direction, the former being rlies," the latter "easterlies." The easterlies e to the non-linear inertia terms in the equations tion. This description of the velocity field is because the experiment described above has erable meteorological significance. A.

532.517

The stability of plane Poiseuille flow. L. H. s. *Phys. Rev.*, **91**, 780–3 (*Aug.* 15, 1953).

problem of the stability of plane Poiseuille flow ıll disturbances leads to a characteristic value m for the Orr–Sommerfeld equation with given ary conditions. It happens that negative values imaginary parts of the characteristic numbers, indicate instability, are small, at any rate over gion here investigated, and considerable cy is required to establish them, while the Reynolds numbers for which they occur are large. The fourth-order differential equation is here replaced by a difference system of the same order with a truncation error involving the eighth derivative, so that the error is sufficiently small with a reasonably large interval. The resulting system of linear algebraic equations is solved by direct Gaussian elimination, which avoids the difficulties due to rapid exponential growth of error for high Reynolds number which beset the standard integration procedure. The characteristic value is obtained for a range of Reynolds numbers and wavelengths of the disturbance, and the critical Reynolds number found to be 5780 for wavelength 3·062 times the width of the channel. A detailed discussion of the accuracy of the work is given for the (unstable) case of wavelength π and Reynolds number 10 000, and a table of the profile of the disturbance is given for this case. A.

532.517.4

7487. The theory of homogeneous turbulence. G. K. Batchelor. *Cambridge*: *University Press*, xi + 197 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 285 (*Sept.*, 1953).

532.59

7488. Wave motion in an annular tank. I. J. Campbell. *Phil. Mag.*, **44**, 845–53 (*Aug.*, 1953).

It has been found that large wave disturbances occur when a water whirling arm is operated at certain speeds. A theoretical treatment of this phenomenon is given. Visual observations of disturbances on the surface of the water in the tank confirm the theoretical expectations. A.

532.592

7489. An approximate solution of the problem of the solitary wave. A. Apté. *C.R. Acad. Sci.* [*Paris*] **236**, 2477–9 (*June* 29, 1953) *In French.*

An approximate solution of the problem of the solitary wave is derived along lines suggested by the work of Danel and of Kravchenko. Essentially, the method of solution is to determine values of two parameters, h and k, so that along a line L (representing the wave profile), inclined at an angle of $\pi/3$ to the axis OY in the $Z(= X + iY)$ plane, the value of the function $\varepsilon = |(V^2/2 + gY) - (V_\infty^2/2 + gY_\infty)|$ in which $V = |df/dz|$ and $f = [(1 - k)/k]i$, is as nearly 0 as possible. Numerical calculations showed that $|\varepsilon| \leqslant 0{\cdot}3\%$ along L if $h = 1{\cdot}8499$ and $k = 1{\cdot}5518$. The ratio of the height of the wave crest to the height of the horizontal asymptote of L is 1·844 in place of the value 1·78 found by Cowan (1894). The curvature of L, at the point $f = [(1 - k)/k]i$, is about 10 times the depth of the billow at ∞, and the degree of approximation in that region is of the first order only. J. S. G. Thomas

CAPILLARITY 532.6

532.612.4

7490. The surface tension of liquid silicon and germanium. P. H. Keck and W. Van Horn. *Phys. Rev.*, **91**, 512–13 (*Aug.* 1, 1953).

The surface tensions of liquid silicon and germanium were determined using the drop weight

method. 600 dynes/cm was found for germanium and 720 dynes/cm for silicon at their freezing points and argon atmosphere. The parachors of the group IVb elements as derived from surface tension measurements of the molten elements are compared with the atomic parachors calculated from compounds. The differences are interpreted as structural parachors which indicate that the bonding between neighbouring atoms in the liquid state increases in nearly uniform steps from lead to tin and to germanium. No further increase of the structural parachor takes place in silicon which is consistent with the fact that only four electrons per atom are available for bonding. A.

532.64 : 541.183

7491. Spreading of liquids on low-energy surfaces. III. Hydrocarbon surfaces. H. W. Fox and W. A. Zisman. *J. Colloid Sci.*, 7, 428–42 (*Aug.*, 1952).

For Pt II, see Abstr. 7076 (1952). Contact angle measurements have been made of a wide variety of liquids on clean, smooth surfaces of polyethylene (I), paraffin (II) and single crystals of *n*-hexatriacontane (C_{36}); the calc. value of the final spreading coefficient is also given. C_{36} and paraffin are not wetted by many organic liquids, including *n*-alkanes, so that the rule that non-polar solids are wetted by non-polar liquids is erroneous. Wettability decreases in the order I, II, C_{36}, because of the increase in the proportion of methyl to methylene groups in the surface. Increase in adhesion of hydrocarbon surfaces to liquids is in the order: liquids containing O or F, aliphatic hydrocarbons, aromatic hydrocarbons. Usually (but not with fluorinated polymers) there is more than one value of the critical surface tension (below which liquids spread on a given surface) for hydrocarbon surfaces, and the reason is discussed.

S. J. GREGG

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

7492. Cryoscopy in molten solvents. Cryoscopy in melted lithium metaborate. G. Zarzycki. *Ann. Phys.* [*Paris*] **8**, 392–440 (*May–June*, 1953) *In French.*

$LiBO_2$ has been found to be an almost ideal molten solvent: it is a definite chemical compound, its m.pt. is stable, reproducible and lower than 1100°C, it crystallizes spontaneously, is a good solvent for the substances to be examined, and its volatility and viscosity are low. The apparatus used for cryoscopy with $LiBO_2$ is described in detail; the determinable temperature differences are of the order of 0·01°C. By the cryoscopy of chlorides in $LiBO_2$ it has been found that both the Raoult's law and Stortenbaker's theorem can be applied to $LiBO_2$ as solvent. The cryoscopic constant of $LiBO_2$ is 15 ± 1, and its calculated heat of fusion is $8{\cdot}3 \pm 0{\cdot}6$ kcal/mole. The cryoscopy of the constituent oxides (Li_2O_3 and B_2O_3) reveals the existence of the O^{2-} ions in the molten solvent, in agreement with the fundamental equilibrium $2LiBO_2 \rightleftharpoons B_2O_3 + 2Li^+ + O^{2-}$. Oxides with 2 metal atoms (Al_2O_3, Fe_2O_3, Co_2O_3, Cr_2O_3) are also dissociated. The pyrophosphate radical $P_2O_7^{4-}$ and a series of fluorides as well as the native Greenland cryolite have been found to be completely dissociated in melted $LiBO_2$. F. L.

7493. Diffusion in binary systems. S. R. de Groot. *J. chem. Phys.*, **21**, 1344–7 (*Aug.*, 1953).

The Onsager–Fuoss equation for the concentration dependence of the diffusion coefficient is derived from a kinetic picture, taking into account the asymmetry in the Brownian motion induced by concentration gradients. Mass flow is introduced by considering diffusion in the presence of a pressure gradient. Systems exhibiting volume changes on mixing are discussed, and a modification of the Matano procedure for calculating diffusion coefficients is suggested. It is shown that diffusion coefficients obtained from steady-state permeability measurements and those obtained from interdiffusion data differ by a factor $\bar{V}_2 c_2$, the volume fraction of the non-permeating component.

7494. Thermal diffusion in binary systems. Prager and H. Eyring. *J. chem. Phys.*, **21**, 1 (*Aug.*, 1953).

Just as is the case with ordinary diffusion, thermal diffusion is accompanied by a mass flow, which does not vanish even after the steady state has been reached. As a result of this mass motion the thermal diffusion coefficients of both components in a binary mixture enter into the expression for the steady-state mole fraction gradient of either one, so that a knowledge of the latter is not sufficient, in general, to determine the total heat of activation for diffusion into a void of hole formation and a heat of activation for jumping. Mass flow should exist even in pure liquids in the presence of a temperature gradient, and this would give rise to the interesting possibility that the heat of activation for self-diffusion can be resolved into its components.

7495. The effect of pressure on diffusion in the system CCl_4–SnI_4. E. P. Doane and H. G. Drickamer. *J. chem. Phys.*, **21**, 1359–61 (*Aug.*, 195

Diffusion coefficients have been measured for the system CCl_4–SnI_4 using I^{131} tagged SnI_4. Isotherms were obtained at 50°C and 75°C to 2000 atmospheres pressure. The results are interpreted in terms of the activation enthalpy, entropy and volume. Below 1000 atm. the diffusion mechanism differs only slightly from that in effect at atmospheric pressure, while at higher pressures orientational effects are observed.

7496. Diffusion in liquid sulfur. R. L. Saxton and H. G. Drickamer. *J. chem. Phys.*, **21**, 1 (*Aug.*, 1953).

Diffusion coefficients have been measured in liquid sulphur over the range 120°C–320°C. Two varieties of sulphur, both treated to remove organic impurities, were used. No essential difference was found between them. The break in the diffusion rate occurs at a lower temperature than does the break in the viscosity curve, and the total drop in diffusion rate is much smaller than the rise in viscosity. The effect of the impurity is also less important for diffusion than for flow. This is attributed to the smaller effective molecular segment in molecular motion.

532.7

The effect of pressure on diffusion in liquid r. D. R. Cova and H. G. Drickamer. *J.* . *Phys.*, **21**, 1364–5 (*Aug.*, 1953).

ffusion coefficients have been measured in liquid ıur to 2500 atm. pressure for isotherms at 140°c, s, 175°c and 210°c. One isotherm was also ned at 195°c for sulphur containing 0·75% iodine. motion in the viscous region is characterized by small activation volumes which indicates that noving segment is very small. This shows why lrop in diffusion rate in the transition region is l compared with the increase in viscosity. The ie reduces the "effective temperature" 10–15°c. ve 1200–1500 atm. only one form of liquid ıur seems to exist. A.

532.7 : 533.7

Molecular theory of fluids. H. S. Green. *erdam: North-Holland Publishing Co.* (1952) – 264 *pp.*

view in *Proc. Phys. Soc.* [*London*] *A*, **66**, 668 1, 1953).

532.72 : 541.64

Dependence of diffusion rate on the concen-n for some polymers in solution. V. N. Tsvetkov, Krozer and L. S. Terent'eva. *Dokl. Akad. SSSR*, **85**, *No.* 2, 313–16 (1952) *In Russian.*

e approximate equation

$$D = (kT/f)(1 + 2BMC/RT)$$

oeff. of friction for forward movement of macro-cules of mol.wt.M; k, Boltzmann, and R, gas, con-s; B, constant characterizing the kinetic mobility ie segments of the polymer chains) is proposed ne relation between the diffusion constant D and oncentration C of a polymer in solution at low ntration. D rises rapidly with C for solutions olyisobutylene in hexane ($M = 6\times10^6$), and less r polystyrene ($M = 6{\cdot}3\times10^5$) in dichloroethane, shows only a slight upward trend for polyvinyl ol ($M = 6\times10^4$) in water. f, calculated with the f the above equation from experimental measure-s of D, increases much less rapidly with C than D indicating that the frictional resistance to ard motion is much less important here than ance to rotational motion of the macromolecules.

R. C. Murray

532.73

Solubility in compressed gases. S. Robin. in *J. Phys. Radium*, **14**, 330–44 (*May*, 1953) *In h.*

review (82 references) of the theory of, and rch on, the solubility of solids and liquids in ressed gases. Describes the methods of measure-and lists substances whose solubility has so far studied. Discusses various formulae and equa-suggested for the interpretation of experimental s. Describes the recent results regarding the al solubility of highly compressed gases.

F. Lachman

532.73

Co-operative orientation in solutions. The acy of the quasi-chemical approximation. J. A. ER. *J. chem. Phys.*, **21**, 1391–4 (*Aug.*, 1953).

accuracy of the quasi-chemical approximation used in the theoretical treatment of a lattice model for solutions in which co-operative orientation of molecules takes place is examined. The quasi-chemical method of Guggenheim and the modified quasi-chemical method of Kikuchi are used to find higher approximations. It is found that the quasi-chemical approximation for pairs is satisfactory for lattices which are not close-packed, though it may be seriously in error for close-packed lattices. A.

532.73 : 541.183 : 541.64

Adsorption on proteins and interactions between protein molecules in solution. *See Abstr.* 8041

532.73–1

7502. On the solubility of hydrogen in certain liquid metals. Y. L. Yao. Letter in *J. chem. Phys.*, **21**, 1308–9 (*July*, 1953).

An attempt, based on the close-neighbour hypothesis, to explain the experimentally confirmed correlation between log x (x being the solubility of H in atomic ratio at 1 atm. pressure and at absolute melting point T_m of the metal) and the expression $(H_s + H_{diss} - 2H_{disp})/T_m$, where H_s is the molar enthalpy of sublimation of the metal at 25°c, H_{diss} is the molar enthalpy of the dissociation of H_2 at 25°c, and H_{disp} is the equivalent enthalpy at 25°c of the reaction $\frac{1}{2}H_2 + 1/n\,M^{n+}$ (aq, $m = 1$) $\rightarrow 1/n\,M + H^+$ (aq, $m = 1$). F. Lachman

532.73–3 : 539.11

7503. On the theory of solutions of alkali metals in liquid ammonia. W. Bingel. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 57–83 (1953) *In German.*

The electrons in the vicinity of holes are assumed to be in states induced by the positive metallic ions. The application of Fermi statistics to the electron distribution yields formulae which, with suitable choice of constants, are in good agreement with the experimental observations of dilation and magnetic susceptibilities in these solutions. T. C. Toye

MECHANICS OF GASES 533

533.15

7504. Diffusion in the system CH_4–TCH_3 to 300 atmospheres pressure. Q. R. Jeffries and H. G. Drickamer. *J. chem. Phys.*, **21**, 1358 (*Aug.*, 1953).

Coefficients have been measured. In general the results are consistent with the predictions of Enskog's dense gas theory. At the highest densities, the diffusion coefficients are lower than the theory predicts. This is expected as, at these densities, unevaluated terms in the dense gas correction become significant. A.

533.5 : 531.787.6 : 621.317.79

7505. A simple diaphragm micromanometer. D. B. Cook and C. J. Danby. *J. sci. Instrum.*, **30**, 238–40 (*July*, 1953).

A diaphragm vacuum gauge covering the pressure range 1 to 100 μ with an accuracy of better than 0·5 μ is described. Movement of the diaphragm is followed by measurement of capacity change. The electronic circuit uses only one valve. The gauge is suitable for

measurement of mass-spectrometer sample inlet pressures. A.

533.583 : 621.385.032.46

7506. Sorption of gases at very low pressures by thorium powder. S. WAGENER. *Proc. Phys. Soc.* [*London*] *B*, **66**, 400–13 (*May*, 1953).

The rate of sorption of thorium powder for oxygen and hydrogen was measured at pressures between 10^{-7} and 10^{-3} mm mercury as a function of temperature of the thorium and of the period of exposure to gas. The sorbed quantities of gas were determined from the variation of rate of sorption with time. It is found that oxygen is sorbed irreversibly, forming a stable oxide with a dissociation pressure which is immeasurably low. The activation energy of this chemisorption is ascertained from the increase of rate of sorption with temperature of the thorium and is found to be about 0·75 kcal/mol. Hydrogen is sorbed reversibly by a process of solution. The correlations between sorbed quantity of hydrogen, hydrogen pressure and temperature of the thorium are those to be expected for an equilibrium of solution. During dissolution of hydrogen heat is evolved and a value of about 13 kcal is found for this heat of solution. There are indications that at very low pressures most of the hydrogen in a tube containing thorium powder is in the atomic state. The rate of sorption for hydrogen has a maximum value between 700 and 750°K. The significance of these results for the application of getter materials in electronic valves is discussed briefly. A.

533.6.011.31

7507. On the asymptotic behaviour of compressible fluid flow at a great distance from a cylinder in the absence of circulation. I. IMAI. *J. Phys. Soc. Japan*, **8**, 537–44 (*July–Aug.*, 1953).

The method of thin-wing-expansion which has been developed by the author is applied to the case of a uniform flow of a compressible fluid past an arbitrary cylinder in the case of the absence of sources, sinks and circulation. The asymptotic expressions for the velocity potential and the stream function at a great distance, r, from the cylinder are determined correctly to the order of $1/r^4$. Hence the velocity can be found exactly to the order of $1/r^5$. This should be compared with Gröbner's result which is correct to the order of $1/r^4$ and is restricted to the case of a cylinder symmetrical with respect to the x-axis. Moreover, the present analysis is far simpler than Gröbner's view of the fact that the former requires only some elementary quadratures while the latter needs the integration of a system of differential equations. Finally, it is shown that the general expression for the velocity potential is in accord with the author's previous result for flow past a circular cylinder, which is correct to the order of M^6, M being the Mach number. A.

533.6.011.311

7508. The laminar boundary layer of a rotating body of revolution. C. R. ILLINGWORTH. *Phil. Mag.*, **44**, 389–403 (*April*, 1953).

By combining the von Mises and the Mangler transformations for laminar boundary layers, it is found that, in some cases, compressible boundary-layer flow round a rotating body of revolution ca correlated to an incompressible flow some similar to plane boundary-layer flow. The boun layer in conefield flow past a rotating circular co thereby considered in detail.

533.6.

7509. Flow of inviscid supersonic jet past an in wedge. D. C. PACK AND L. ROBERTS. Lett *Phil. Mag.*, **44**, 561–3 (*May*, 1953).

533.6.

7510. The supersonic bang. G. M. LILLEY WESTLEY, A. H. YATES AND J. R. BUSING. *N* [*London*] **171**, 994–6 (*June* 6, 1953).

For a source, moving in a straight line at a s which increases and then decreases, through speed of sound, two curved wave fronts are for joined at their outer extremity by cusps. In simple theory of the supersonic bang, it is assu that these waves, which eventually move ahea the retarded source, cause bangs as they pass observer. Although the calculated time inte between the two bangs and the strength of the wave front show reasonable agreement with meas values, calculation, to date, does not predict a sec wave front of strength comparable to the first. instead of the Mach wave configuration, the sh waves round the aircraft, in steady or unsteady fl are considered, this discrepancy between theory experiment does not arise. Experimental res based on the hydraulic analogy technique, using to models, confirm this conclusion. J. S. G. THO

533.6.0

7511. Application of polynomial distributions to determination of the thickness of shock waves. BERNARD. *C.R. Acad. Sci* [*Paris*] **237**, 130–2 (*July* 1953) *In French.*

By polynomial distributions of velocities of m cular agitations are to be understood expressions the form $F = \sum_{i=1}^{i=p} n_i f_i$, in which the values of depend only upon space variables, and in which Maxwellian functions, $f_i = (y_i/\pi)^{3/2} \exp\{-y_i(u - + v^2 + w^2\}$, correspond to arbitrarily chosen va of the parameters, (x_i, y_i), each of which define uniform, uni-dimensional flow; these distributi can therefore be considered as the discontinu form of the composite distributions previou defined [Abstr. 4652 (1953)]. Non-conservative ty of transfer are introduced by considering defi forms of the three equations relating to the us transfers, and the number of distribution terms m be at least 5; numerical results are given for the c of Maxwellian molecules when the number of dis bution terms is limited to 5. J. S. G. THO

MOLECULAR THEORY OF GASES 533.7

53

7512. The mathematical theory of non-uniform ga S. CHAPMAN AND T. G. COWLING. *Cambrid University Press*, xxiii + 431 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 223 (*July*, 1953)

533.7

Negative cluster concentrations. J. E. Kil-ck. *J. chem. Phys.*, **21**, 1366–7 (*Aug.*, 1953).
number of clusters of a given size in a real gas ntly turns out to be negative. Nevertheless, a based upon the cluster idea leads to the correct expansion. This model is tested further by a calculation of the gas imperfection entropy the possibly complex entropy of formation and ing of these clusters. A.

VIBRATIONS . ACOUSTICS 534

534.013.2

Nomographic solution for three-mass systems. Callaghan. *Frequenz*, **7**, 63–4 (*March*, 1953) *man.*
imensionless, nomographic construction is given termining the resonances of three-mass, two-systems. See also Abstr. 1442–3, 5331-5 (1953). C. F. PIZZEY

534.013.2

Effective masses in plants with in-line- or motors. T. O'Callaghan. *Frequenz*, **7**, 64–71 *h*, 1953) *In German.*
cusses the effects of additional rotating masses ed at one end, or at both ends, of motors. ck-motor is defined as one in which the cylinders nstructionally in pairs.) C. F. PIZZEY

534.013.2

Torsional vibrations of systems with con-s mass- and stiffness-distribution. T. O'Calla- *Frequenz*, **7**, 101–12 (*April*, 1953) *In German.*
systems considered are: aircraft wings; aircraft llers; disks, mainly those of hyperbolic form. oncept of effective mass in continuous structures ussed, and two derivations of the E.-M. equation Worked examples are of a wing, and a disk damper incorporating rubber. C. F. PIZZEY

534.013.2

An electrical resistance analogy of torsionally ing systems. T. O'Callaghan. *Frequenz*, **7**, 6 (*April*, 1953) *In German.*
the arrangement described, the masses are ented by proportional resistances, and the shaft ss by a proportional e.m.f.; the current is then rtional to ω^2. C. F. PIZZEY

534.014.2

The nature of solutions of a Rayleigh-type vibration equation with a large coefficient of ng. P. Brock. *J. appl. Phys.*, **24**, 1004–7 1953).
nsiders an approximation to the Rayleigh on, $\ddot{y} + \varepsilon(\frac{1}{3}\dot{y}^3 - \dot{y}) + y = A\cos\omega t$, and its ulent form under the transformation $\dot{y} = v$, ξ. A cubic function $\frac{1}{3}v^3 - v + \xi$ that appears altered equation is replaced by a piecewise function. For large ε, the existence of periodic ns of the approximating equation is demon-l. Strong orbital stability properties of neigh-ng solutions is also shown. A.

534.1

7519. Self-oscillations in essentially non-linear quasi-conservative systems. G. V. Savinov. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 6, 995–7 (1953) *In Russian.*

534.112 : 530.145

7520. Canonical field theory—a prototype example. B. W. Knight, Jr. *Amer. J. Phys.*, **21**, 421–7 (*Sept.*, 1953).

The equations of a field may be put into a standard "Lagrangian" form from which several conservation laws follow directly. As an illustrative example, a string free to vibrate in two directions is investigated; this example clearly illustrates the outstanding features of the canonical theory, while avoiding the notational and physical complications encountered in most systems of practical interest. The conservation laws are interpreted for the string. The theory is further developed to express the field's behaviour in terms of canonical co-ordinates and momenta. Quantum conditions are introduced, as in meson theory and quantum electrodynamics. It is shown that the mathematics of the "quantized string" is that of several charged particles occupying a set of energy states. A.

534.14

7521. Sounds of jets. E. G. Richardson. *Nature* [*London*] **172**, 54–6 (*July* 11, 1953).

A brief historical summary of the formation of "edge" and "jet" tones. Reference is made to the early work of Tyndall and later that of Rayleigh on sensitive jets and flames, followed by references to the "edge tones" of Sondhauss and Wachsmuth. After mentioning Karman's theory of vortex streets, the author gives a brief account of his own experimental and theoretical work and that of A. Powell, W. L. Nyborg and E. J. Richards. The paper concludes with a brief reference to the papers relating to jets, read at the recent symposium on "Aeronautical Acoustics, in particular Jet Noise" held in London under the auspices of the Royal Aeronautical Society and the Acoustics Group of the Physical Society.

A. B. WOOD

534.153 : 534.231

7522. Schlieren photographs of sound fields. D. S. Schwartz and A. L. Russo. Letter in *J. appl. Phys.*, **24**, 1061–2 (*Aug.*, 1953).

The sound-generating mechanism of turbulent jets, both supersonic and subsonic, has been investigated with the sensitive Schlieren system described. Some practical details of the apparatus and sample photographs are given. R. W. FISH

534.22

7523. Contribution to the study of ultrasonic dispersion in compressed gases. A. Lacam and J. Noury. Letter in *J. Phys. Radium*, **14**, 272–3 (*April*, 1953) *In French.*

534.22

7524. Variation of the speed of ultrasonics in ethane near the critical region. J. Noury. Letter in *J. Phys. Radium*, **14**, 348–9 (*May*, 1953) *In French.*

Light diffraction measurements show the relation between speed of ultrasound and pressure at a number of frequencies near the region of critical pressure.

T. C. TOYE

534.22

7525. Speed of ultrasonics in nitrogen at pressures up to 1150 atmospheres. A. LACAM. Letter in *J. Phys. Radium*, **14**, 351–2 (*May*, 1953) *In French.*

The variation with pressure of the speed of propagation of ultrasound in nitrogen has been measured by the light diffraction method. Agreement with theory is found. T. C. TOYE

534.22 : 532.12

7526. Molecular sound velocity and molecular compressibility of liquid mixtures. O. NOMOTO. *J. Phys. Soc. Japan*, **8**, 553–60 (*July–Aug.*, 1953).

The molecular sound velocity of Rao, $R = M/\rho \cdot V^{1/3}$ and the molecular compressibility introduced by Wada, $B = M/\rho \cdot \beta^{-1/7}$ $(= M/\rho^{6/7} \cdot V^{2/7})$, where M is the molecular weight, ρ the density, V the sound velocity and β the adiabatic compressibility, have been computed for 37 mixtures of mutually soluble liquids employing existing ultrasonic velocity data and the number average molecular weights. Although the sound velocity in and the adiabatic compressibility of liquid mixtures are known to be not necessarily monotonic functions of the concentration, exhibiting maxima or minima in some cases, the molecular compressibilities were found to be linear functions of concentration (molar fraction) in most of the liquids examined. The molecular sound velocities were found to be linear functions of the molar fraction in many of the mixtures, but they deviated from straight lines and became concave upwards in mixtures consisting of one heavy component (such as carbon tetrachloride and chloroform) and one light component. Both R and B, however, failed to be linear functions of molar fraction in water–alcohol mixtures, slightly deviating upwards from the straight lines, with maxima of deviation in the neighbourhood of the concentrations corresponding to the velocity maxima. A few mixtures showed irregular R- and B-curves. This is presumably attributable to the inaccuracy of velocity data employed. A.

534.22 : 536.633.3

Ultrasonic velocity and ratio of specific heats of gases. *See Abstr.* 7642–3

534.23 : 535.417

7527. Ultrasonic interferometry in gases. III. Velocity and absorption of ultrasound in sulphur dioxide. S. PETRALIA. *Nuovo Cimento*, **9**, 818–24 (*Sept.*, 1952) *In Italian.*

For Pt II, see Abstr. 1455 (1953). These have been measured at different frequencies. The molecular heat capacity C_i due to the internal vibrations of the molecules, the relaxation time τ of the vibration energy and the probability P_{10} of disexcitation of the vibration states are calculated. The author finds $C_1 = 1{\cdot}476$ cal/mole, $\tau = 1{\cdot}85 \times 10^{-7}$ sec and $P_{10} = 0{\cdot}54 \times 10^{-3}$. A.

534.23

7528. Calorimetric determination of the coefficient of absorption of sound in organic liquids. S. PARTHASARATHY, S. S. CHARI AND P. P. MAHENDROO. *J. Phys. Radium*, **14**, 366–8 (*June*, 1953) *In French.*

Using a calorimeter previously described by the authors, the coefficient of absorption at 5 Mc/s is determined by measuring the heat evolved during sound transmission. Good agreement wit results obtained by radiation pressure meth observed. T. C

534.23 : 5

7529. Equivalence of sonic and thermal en S. PARTHASARATHY, S. S. CHARI AND D. SRINI *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 8–16 (1953).

An experimental determination of the re between the energy of sound waves com absorbed in a trough of liquid and the hea produce. A value for J of $4{\cdot}19 \times 10^7$ ergs/ obtained. T. C

53

7530. On the mode of vibration of the surfac piezoelectric quartz plate. E. GROSSETTI. *Cimento*, **10**, 151–6 (*Feb.*, 1953) *In Italian.*

The investigation of the diffusion of ultra waves in liquids has been extended to a much l frequency field [Abstr. 7629 (1951)]. With col solutions of Ag and S at frequencies of 0·3 4·2 Mc/s no variation was observed. With soli of water–burnt sugar and water–glycerin there clearly a variation of the intensity distributio different quartz source was also used and ma oscillate on four different frequencies. The r showed that the shape of oscillation of the c depends on the liquid. In this way the result of according to which the emitting surface of the does not remain plane during the vibration, was verified.

534.232 : 621.395.623.7 : 621.317.

7531. Measurement of linear and non-linear tortion in electrodynamic loudspeakers. [Måling lineær og ulineær forvrængning i elektrodynam høgttalere.] F. INGERSLEV. *Copenhagen*: *Te Forlag* (1953) 266 *pp. In Danish, with* 13 *pp. E summary.*

Deals with the general problem of linear (frequ attenuation and phase) and non-linear (harmo sum and difference tones, etc.) distortion in l speakers. The author holds the view that obje tests are, for a number of reasons, preferabl subjective tests, although, of course, these eventually be reconciled. The present work primarily with objective tests of loudspeaker di tion—studying the loudspeaker unit itself and the influence of a baffle or cabinet of a broadca receiver. Chapter I deals with the primary cons of the loudspeaker, the dynamics of motion of diaphragm, the magnetic system and method measuring the motion of the coil in respect of linear distortion. Chapter II deals with li distortion, especially frequency distortion—atte being drawn to the importance of choice of dist at which the measurements are made. Finally, influence of the baffle is discussed. The ge theory of non-linear distortion is discussed i later section. A. B. WOOD

534.24 : 539.219 : 620.17

7532. Ultrasonic detection of stratifications materials without machining of surface. V. S. SOKO *Elekt. Stantsii*, **1953**, *No.* 1, 24–7. *In Russian.*

The output of a 50–600 kc/s multivibrator is app to a barium titanate disk, contained in a pr

vibrations are transmitted through oil and a diaphragm to the object under test. Vibrapass unhindered only through sound material, other side of which a similar probe with a diaphragm has a Rochelle salt receiver. The lectric effect in this receiver is amplified and sult applied to a galvanometer whose full ion indicates sound material. Defects $>0{\cdot}5$ cm^2 a cause smaller deflections and thus stratifis, air inclusions and cracks can be detected in steel, rubber, plastics and concrete. The ess of metal that can be controlled ranges from ns of mm to several hundred mm. The whole of a moving strip can be controlled using l probes. Water on the surface improves the t of the rubber diaphragm and hence of the sults. J. LUKASZEWICZ (R)

534.372

Damping of an oscillating quartz in liquids s relation to viscosity. S. PARTHASARATHY AND CHHAPGAR. Letter in *J. Acoust. Soc. Amer.*, **25,** (*July*, 1953).

ts were made at 3·27 Mc/s, the piezoelectric t arising from the damped vibrations of the being employed to give the corresponding d pattern on a c.r.o. The efficiency of oscilla- $Q = 2\pi fL/R$, was determined for 10 liquids. the crystal is loaded by immersing in different s media, its damping resistance, R, should se and thus Q should decrease with increasing viscosity. With liquids having a high value of l viscosity, Q should decrease markedly. lly, the experimental results showed a linear or log Q *v.* log viscosity, although some of the used have shown anomalous absorption. sults indicate that these anomalous absorptions t be due to anomalous viscosities. A. C. WHIFFIN

534.41 : 532.525

Jets of water sensitive to sound. M. DUBOIS. *Acad. Sci.* [*Paris*] **237,** 143–4 (*July* 15, 1953) *In* .

ow frequency sound source is used to excite ed water jets of variable velocity issuing from aries and descending vertically through water ank. The effect of sound frequencies between 00 c/s on the jets is studied. Results similar se obtained with sensitive gas jets are obtained e similarity is briefly discussed. G. F. HODSMAN

534.415 : 621.396.619.13

Estimating the extent of frequency modulation ns of a stroboscope. J. F. NICKERSON. Letter *Acoust. Soc. Amer.*, **25,** 796–7 (*July*, 1953).

cribes an application of the chromatic strobo- in estimating the extent of modulation of an f.m.

Discusses the "logic" of the stroboscope by of which two systems of energy are syn- zed, using a psychophysical judgment—the nical system of the whirling stroboscope disk e periodic energy of the original signal. Once nchronization has been made, there is a one-to- rrespondence between the two systems. If nal is modulated, the synchronization can be d to either the upper or lower limits of the ation or to the mean. Thus by "a second kind of synchronization" of the visual pattern of the stroboscope one can readily estimate the extent of the frequency modulation of signals. Particular reference is made to the application of this method to musical vibrato. A. B. WOOD

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 8149

534.861.1

7536. Helmholtz resonators as acoustic treatment at the new Swansea studios. F. L. WARD. *B.B.C. Quart.*, **7,** *No.* 3, 174–80 (1952).

Describes a special study made at the B.B.C. research laboratories of the use of Helmholtz resonators as low frequency sound absorbers. Sound absorbers of this type have been used in broadcasting studies on the Continent, but their application in the largest ($51\times28\times25$ feet) of the rebuilt Swansea studios is the first example of their use in this country. A discussion is given of the characteristics of Helmholtz resonators and their properties when arranged in a line. Reverberation room measurements and the final form of the resonators are described. Curves are reproduced which show the steady decrease of the reverberation time of the studio during the progress of its construction. Resonators of frequencies 75 and 150 c/s were used to absorb the low frequencies. The final good performance of the studio is attributed to the absence of masking by bass instruments. A. B. WOOD

OPTICS . RADIATION . SPECTRA 535

535.1 : 530.145

Motion of a particle across a potential jump. *See Abstr.* 7469

535.23.08 : 536.33 : 538.56

7537. The concept of radiation measurements. D. J. LOVELL. *Amer. J. Phys.*, **21,** 459–62 (*Sept.*, 1953).

Concepts are defined which are suitable for discussing all portions of the electromagnetic spectrum. The concept of "light" is limited to that portion of the spectrum called the visible region. The term radiation is employed as a more general concept. Similarly general and fundamental terms are used to illustrate techniques of teaching radiation without the confusion frequently connected with the psychophysical concepts of photometry. A.

535.241 : 535.32

7538. The effect on illuminance of a lens interposed between the source and the illuminated surface. R. E. STEPHENS. Letter in *J. Opt. Soc. Amer.*, **43,** 704 (*Aug.*, 1953).

Transmission and focal length of the lens varies with wavelength so that the spectral distribution of the light is modified; a typical case is calculated.

G. F. LOTHIAN

535.247 : 621.383 : 621.327.4

7539. Neon indicator tubes as quantitative detectors in photometry. T. J. DILLON. *Brit. J. appl. Phys.*, **4,** 245–7 (*Aug.*, 1953).

The photosensitive properties of certain types of

neon indicator tubes in relaxation oscillator circuits have been investigated and used in a frequency light meter. Illumination is measured in terms of change of frequency caused by the alteration in the striking potential on irradiation. The experimental results are in accord with the theory and illuminations range from 50 to 10^4 f.c. Sample calibration curves at low and high levels of illumination are given for a number of tubes. A.

535.247.4 : 621.383

7540. On the question of the relation between photocurrent and illumination intensity in photocells and photomultipliers. G. KÖRTUM AND H. MAIER. *Z. Naturforsch.*, **8a**, 235–45 (*April*, 1953) *In German.*

Photomultipliers have recently been used for the photometry of weak sources and it has been assumed that the output is directly proportional to the input to within the precision of the measurements ($\sim 1\%$). The paper demonstrates that this is not the case with commercial photocells and photomultipliers. Errors of $>10\%$ are observed and these devices may only be used in true null methods with optical compensation for changes in light intensity. The departures are due to decay effects in the semiconducting surfaces, space-charge effects and temperature effects. A bibliography of 39 items is included. A. H. W. BECK

535.312

7541. Beam displacement on reflection. C. V. FRAGSTEIN AND C. SCHAEFER. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 84–8 (1953) *In German.*

An extension of Abstr. 4808 (1950) accounting for the sideways beam displacement effect reported to occur at total reflection, and also predicted for reflection by absorbing media. The theory formerly given has been criticized by Artmann [Abstr. 5308 (1951)]. Artmann's objections are answered in terms of energy flow theory. S. TOLANSKY

535.312.2

7542. Parallel reflection of light by plane mirrors. J. B. KELLER. *Quart. appl. Math.*, **11**, 216–19 (*July*, 1953).

It is shown that, in addition to the well-known "corner reflector" employing three mutually orthogonal plane mirrors, an incident ray will be reflected back parallel to its original direction by other configurations of three mirrors. These are configurations in which the sets of dihedral angles are $(n/2, n/3, n/4)$, $(n/2, n/3, n/5)$ and $(n/2, n/2, n/n)$ where n is an even integer. D. G. AVERY

535.313.6

7543. Permitted tolerance on percent correction of paraboloidal mirrors. P. R. YODER, JR, F. B. PATRICK and A. E. GEE. *J. Opt. Soc. Amer.*, **43**, 702–3 (*Aug.*, 1953).

Third-order theory is used to derive an expression for the tolerance on the percent correction of a paraboloidal mirror from the Rayleigh limit of residual spherical aberration. This tolerance is found to depend upon the focal length of the mirror and the radius of the zone being tested. The variation of the tolerance for different zones of the mirror is shown graphically by applying the tolerance to the Foucault test of an $F/6$ paraboloid of focal length 48 inches. A method is given for determining the maximum aperture permitted if a spherical surface is substituted for a paraboloidal one.

53

7544. Models illustrating optical coma and matism. C. CURRY. *Proc. Leeds Phil. Lit. So* 78–81 (*Dec.*, 1952).

535

7545. The light distribution in geometric-o image patterns in arbitrary image planes for o systems with spherical surfaces. A. THOMES *Optik*, **10**, *No.* 5, 221–36 (1953) *In German.*

Equations are given allowing the computati the light distribution throughout the image pla centred ray bundles. The equations are com with those of Staeble, Malinkowski and H The method is extended to the case of skew bundles and allowance is made for reflection absorption losses. R. W.

535

7546. An extended Smith–Lagrange invariant. ROGERS. Letter in *Nature* [*London*] **172**, 118 (*Ju* 1953).

In two-stage processes of image-formation invo the successive use of different wavelengths the inva needs to be written $\mu h \sin\alpha/\lambda$, the wavelen being included as well as refractive index μ, height h, and angular radius of a selected ray. over, in this form, the invariant expresses the servation of the degree of coherence from image to image plane. H. H. HO

53

7547. Measurement of the refractive inde amorphous selenium between 5 and 15 μ. L. Hi *C.R. Acad. Sci.* [*Paris*] **237**, 148–9 (*July* 15, 195 *French.*

Using interference in thin films, prepared by poration of Se on to collodion and metal foil s taneously. The density is taken as 4·30. The varies from $2{\cdot}42 \pm 0{\cdot}02$ to $2{\cdot}38 \pm 0{\cdot}02$, for fr prepared Se. The index varies on ageing, due t transition of amorphous red Se to grey Se. C. TU

535.323 : 53

7548. The optical properties of natural and synt hackmanite. D. B. MEDVED. Letter in *J.* *Phys.*, **21**, 1309–10 (*July*, 1953).

535.33.03 : 54

7549. Contribution to the methods and techn of flame spectrography and flame photometry. I. SCHUHKNECHT. *Optik*, **10**, *No.* 5, 245–68 (195 *German.*

A detailed account of the history, principles methods of flame spectrography. Some exa are given of applications to heavy metal analysis. S. T. HENDE

535.33.03 : 54

7550. Contribution to the methods and techniq flame spectrography and flame photometry. II. SCHUHKNECHT. *Optik*, **10**, *No.* 6, 269–302 (1 *In German.*

A discussion of flame photometry (see prece Abstr.) with references to optical filters and pb cells used, and with extensive data on the effec impurities in a solution other than the one t

rsed. Calibration curves are given for the rsis of K, Na, Li and Ca, each by itself or with ddition of one of the following: K, Na, Li, Ca, Sr, Cr, Mn, Al, Mg, Cd, Zn. An extensive ography refers to all the methods of analysis ; flame excitation. S. T. HENDERSON

535.33.07

. **A kinematically focused concave-grating rometer.** E. J. Bair, P. C. Cross, T. L. Dawson, . Wilson, Jr, and J. H. Wise. *J. Opt. Soc.* ., **43**, 681–4 (*Aug.*, 1953).

description is given of a 21 ft concave-grating rometer which achieves the compactness of the arrangement and the convenience of being to scan with automatic focusing. The principal re consists of turntables which translate at opriately different speeds and the connecting arms which rotate them in proper relation to Rowland circle to maintain the focusing conditions. tographic, photomultiplier and photoconductor ding systems can be quickly interchanged. A.

535.33.07 : 53.087

mi-automatic recording of wavelength data. *See* . 7413

535.33.07 : 535.243

. **A method for continuous flushing of an infra- spectrophotometer with dry nitrogen.** O. H. BLER. Letter in *J. Opt. Soc. Amer.*, **43**, 705 ., 1953).

quid N_2 is evaporated continuously; 50 litres per is used for a Beckman IR2. G. F. LOTHIAN

535.33.07 : 535.243

. **The design of a ratio-recording spectro- ometer with double-pass monochromator.** S. F. D. Letter in *J. Opt. Soc. Amer.*, **43**, 709–10 (*Aug.*,).

itably phased chopping should permit the use of ouble-pass monochromator in the system of tzky and Halford [Abstr. 5681 (1950)].

G. F. LOTHIAN

535.33.07 : 535.375.5

. **Relative speeds of Raman spectrometers.** F. Hasler; R. F. Stamm and C. F. Salzman. ers in *J. Opt. Soc. Amer.*, **43**, 708 (*Aug.*, 1953).

nder the conditions described by Stamm and man [Abstr. 2327 (1953)] the length of slit em- ed was that for photographic recording on the rometer, and not that used for direct-reading ysis, a factor of 3 in speed thus being gained. m and Salzman state in their reply that this d cause an increase in the value of the quantity $\times B_\lambda)] \times 10^5$ from 1·2 to 3·6. G. I. W. LLEWELYN

535.33.07–31

. **Method of photographic spectrophotometry in far ultraviolet.** N. Astoin and B. Vodar. *ays. Radium*, **14**, 494–5 (*July–Aug.–Sept.*, 1953) *rench.*

ith a grating spectrograph and condensed spark, d Q1 plates have been calibrated by using different sure times. Measurements of the transmission of Cu gauze agree with the transmission found photo- rically in the visual region, showing that reci- ty errors are unimportant in the conditions used.

G. F. LOTHIAN

535.33.072 : 535.892 : 537.523.4/.5

7556. A low-voltage spark generator for spectrographic analysis. T. Török. *Acta tech. Hungar.*, **6**, *No.* 3–4, 429–42 (1953).

This device includes a capacitor which can be discharged across gaps of 6–8 mm every second half-cycle of the a.c. supply at the circuit inductance of 1·25 μH. No auxiliary spark gap is required for gaps below about 2 mm. The electrical processes and details of the charging, discharging and igniting circuits are discussed. G. HOWELLS

535.338

7557. The splitting of spectral terms. V. Thorsen. *Fysisk T.*, **51**, *No.* 1–2, 32–49 (1953) *In Danish.*

The interpretation of the higher correction terms in the expansion of the relativistic factor $(1 - v^2/c^2)^{\frac{1}{2}}$ occurring in the term energies as "splittings" leads to formulae for the doublet separations which reproduce the experimental values for H and H-like atoms.

W. J. SWIATECKI

535.338.33

7558. A "magnetic scanning" method for investigating hyperfine structure and isotope shift. F. Bitter, H. Plotkin, B. Richter, A. Teviotdale and J. E. R. Young. Letter in *Phys. Rev.*, **91**, 421 (*July* 15, 1953).

A monochromatic light source of variable frequency was obtained by passing the 2537 Å radiation, emitted axially from a Hg^{198} lamp in a magnetic field, through a quarter-wave plate and a Nichol prism adjusted so that only one σ component of the normal Zeeman triplet was transmitted. The frequency displacement depends linearly on the field. The method has been applied to the investigation of the h.f.s., of the resonance lines of the natural isotopes of mercury and the radioactive isotope Hg^{197}. J. HUGHES

535.338.332

7559. Hyperfine structure of the spectrum of ruthenium. K. Murakawa. *J. Phys. Soc. Japan*, **8**, 535–6 (*July–Aug.*, 1953).

The hyperfine structure of the spectrum of Ru I was studied, and a displacement effect of the order of 0·015 cm^{-1} between even isotopes having the difference of two neutron numbers was found in the lines corresponding to the transition $5s - 5p$. The spins of the odd isotopes were found to be $9/2 \geqslant I \geqslant 5/2$, the nuclear magnetic moments being negative. A.

535.338.333

7560. On the isotope shift in the resonance line of ytterbium. K. Krebs and H. Nelkowski. Note in *Naturwissenschaften*, **40**, *No.* 9, 268 (1953) *In German.*

In previous work the shifts in the 5556 Å and 3988 Å lines were calculated for the various isotopes on the assumption that Yb^{170} did not exist. As afterwards the existence of Yb^{170} was proved, these shifts were recalculated from the hyperfine structure of the line. For 5556 Å $\Delta\nu$ (170–176) was found to be 101, for 3988 $\Delta\nu$ (170–176) < 55. A. J. TAYLOR

535.338.4

7561. Studies of the blue bands of the SrO molecule. I. Kovács and A. Budó. *Ann. Phys.* [*Leipzig*] **12**, *No.* 1–3, 17–25 (1953) *In German.*

The detailed results of the rotational analysis of six bands of the blue system, $^1\Pi$–$^1\Sigma$, are given.

The lower state is probably $^1\Sigma^-$, the ground state of SrO. See Abstr. 2335 (1953). R. F. BARROW

535.338.4 : 539.132

7562. The band spectrum of calcium oxide in the violet and ultraviolet regions. A. LAGERQVIST. Note in *Naturwissenschaften*, **40**, *No.* 9, 268–9 (1953) *In German.*

The preliminary results are given of the rotational analyses of two systems, $B^1\Pi - X^1\Sigma$ and $C^1\Sigma - X^1\Sigma$. The state $X^1\Sigma$ is also the lower state of the infrared system [Abstr. 3437 (1951)]. The constants (cm^{-1}) are: $B^1\Pi$: $T_0 = 25\,913$, $B_0 = 0{\cdot}395$. $C^1\Sigma$: $T_0 = 28\,772$, $B_v = 0{\cdot}372_5 - 0{\cdot}003(v + \frac{1}{2})$, $G_v = 560(v+\frac{1}{2}) - 3{\cdot}8(v+\frac{1}{2})^2$. There are perturbations in both systems. R. F. BARROW

535.343–15

7563. Preliminary research on the infra-red absorption spectra of silica gels. A. CHEVET. *J. Phys. Radium*, **14**, 493–4 (*July–Aug.–Sept.*, 1953) *In French.*

Wet silica gel shows a broad OH association band at 3450 cm^{-1}. On heating, this band gradually disappears, leaving a band at 3770 cm^{-1}; this is considerably displaced from the normal position of the free OH band and hence the mode of fixation of the residual water needs further investigation.

G. F. LOTHIAN

535.343–31

7564. The absorption spectrum of aluminium monofluoride in the Schumann region. H. C. ROWLINSON AND R. F. BARROW. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 771–2 (*Aug.*, 1953).

535.343–31

7565. Ultraviolet spectra of aromatic compounds. R. A. FRIEDEL AND M. ORCHIN. *New York*: *John Wiley and Sons*; *London*: *Chapman and Hall* (1951) 52 *pp.* + 579 *spectra.*

Review in *Nature* [*London*] **172**, 223 (*Aug.* 8, 1953).

535.343.2/.3–15

7566. The infrared spectrum of the H_3O^+ ion in acid hydrates. D. E. BETHELL AND N. SHEPPARD. Letter in *J. chem. Phys.*, **21**, 1421 (*Aug.*, 1953).

The infrared spectra of liquid and solid HNO_3, $HNO_3 . H_2O$, $HClO_4$ and $HClO_4 . H_2O$ have been taken from 550 to 4000 cm^{-1}. The liquid acid hydrate seems to be essentially unionized, but the appearance of strong absorption bands in the spectrum of the crystalline hydrate infers the presence of the H_3O^+ ion. By correlation with the spectrum of NH_3, which is isoelectronic with H_3O^+, the observed absorption frequencies are assigned.

G. I. W. LLEWELYN

535.343.2–15

7567. Study, by means of a thermobalance and the infrared absorption spectrum, of calcium sulphate anhydrate, hydrated and deuterated. C. PAIN, C. DUVAL AND J. LECOMTE. *C.R. Acad. Sci.* [*Paris*] **237**, 238–40 (*July* 20, 1953) *In French.*

As part of a general study of water in crystals the infrared absorption spectra of the calcium sulphates in powder form were recorded. In the region 2100–3600 cm^{-1} they allow analytical distinction to be made by means of bands, characteristic of the SO_4 groups or of H_2O or D_2O molecules. J. JACOBS

535.343

7568. The (OH) absorption bands of phenol be 1100 and 1400 cm^{-1}. P. BARCHEWITZ. *C.R. Sci.* [*Paris*] **237**, 237–8 (*July* 20, 1953) *In French.*

Bands at 1370 and 1230 cm^{-1} found at concentrations are attributed to deformation tions of associated molecules. Bands at 134 1175 cm^{-1} found at low concentrations corresp unassociated molecules. Tertiary dibutyl cresol behaves similarly in this region. G. F. LO

535.343

7569. The ultraviolet absorption spectra o aliphatic terpenic alcohols from 2000 to 2 Y.-R. NAVES. *C.R. Acad. Sci.* [*Paris*] **237**, (*July* 15, 1953) *In French.*

On using photoelectric spectrometers between and 2150 Å "false energies" must be elimi Careful elimination shows that α- and β-citron and mixtures of these, β-geraniol+β-nerol β-linalol show no absorption in this region. C. TU

535.343.

7570. Infrared spectra of solutions of io D. L. GLUSKER, H. W. THOMPSON AND R. S. M KEN. Letter in *J. chem. Phys.*, **21**, 1407–8 (*Aug.*, 1

Appreciable shifts of position of certain sc bands, thought to be due to complex forma occur when iodine is dissolved in certain dried solv e.g. mesitylene, diethyl ether, acetone, ethyl ac benzophenone, etc. The shifts observed are numerous on solution of iodine in pyridine an picolines, probably due to formation of ions or molecules such as $[PyI]^+ . [I]^-$. G. I. W. LLEW

535.

7571. Fine structure of the $2\nu_3$ band of met D. H. RANK, J. M. BENNETT AND T. A. WIG Letter in *J. Opt. Soc. Amer.*, **43**, 707–8 (*Aug.*, 1

The fine structures of the lines of the *P*, *Q*, *R* branches of the $2\nu_3$ band of CH_4 have been rese for *J* values of >5. G. I. W. LLEW

535.343

7572. New lines of the inversion spectrum ammonia. T. NISHIKAWA AND K. SHIMODA. N *J. Phys. Soc. Japan*, **8**, 426 (*May–June*, 1953).

535.343.4–14 : 539

7573. Microwave investigation of pyridine. B. AND J. RASTRUP-ANDERSEN. Letter in *J. chem. P* **21**, 1305–6 (*July*, 1953).

Interpretation of the pyridine spectrum 19 000 to 21 000 Mc/s indicates C–C 1·40 Å, 1·34 Å and C–H 1·05 Å. D. H. WH

535.343

7574. Infrared absorption of the frequency compressed CH_4 gas. R. COULON, B. OKSEN AND S. ROBIN. Letter in *J. Phys. Radium*, **14**, 3 (*May*, 1953) *In French*:

This frequency is forbidden in absorption, b now observed, with no resolved structure, at pres of 25–500 atmospheres. G. F. LOT

535.343.

7575. The vibration-rotation spectrum of I W. S. BENEDICT, N. GAILAR AND E. K. PL Letter in *J. chem. Phys.*, **21**, 1301–2 (*July*, 1953).

The absorption spectrum of D_2O vapour has

in the region 2400 to 8000 cm^{-1}, and about nes of D_2O measured. The analysis of the nown bands in this region has been improved ended, and five new bands have been measured, ng the symmetrical stretching vibration, ν_1, ·79 cm^{-1} and its overtone at 5291·55 cm^{-1}. ber of perturbations have been identified. The are summarized in a table of band-origins, e rotational constants and moments of inertia.

R. F. BARROW

535.343.4–15

The vibration-rotation spectrum of HDO. BENEDICT, N. GAILAR AND E. K. PLYLER. n *J. chem. Phys.*, **21**, 1302–3 (*July*, 1953).

absorption spectrum of HDO vapour has been in the region 2400 to 6800 cm^{-1}, and over nes have been analysed into 9 bands. The nce of both type A and type B rotational ons in a single vibrational transition is note- : of the bands observed, five are pure type A, e hybrids with nearly equal intensity, and only band is predominantly type B. The fact that leads to Fermi resonance effects, which are, r, of smaller magnitude than predicted. The s agrees well with microwave results, and also the identification of nearly all of the hitherto tified lines in the pure rotation spectrum. The are summarized in a table of band-origins, e rotational constants and moments of inertia.

R. F. BARROW

535.343.4–15

Measurements of intensity and width of ion lines in the infrared. Variation with e. J. VINCENT-GEISSE. *C.R. Acad. Sci.* **237**, 149–51 (*July* 15, 1953) *In French.*

sideration of a formula deduced previously 5958 (1953)] shows that the intensity of a not be deduced by extrapolation of measure- o zero pressure. But if the gas be mixed with a sorbing gas at constant total pressure, extra- n of absorption measurements to zero partial e of the absorbing gas gives both the line y and line width. Measurements of these ies have been made for the fundamental CO

G. F. LOTHIAN

535.343.4–15

The infrared spectra of HCl, DCl, HBr, and n the region from 40 to 140 microns. R. L. ER AND R. A. OETJEN. *J. chem. Phys.*, **21**, (*Aug.*, 1953).

pure rotation spectra of HCl, DCl, HBr and the region from 40 to 140 microns as measured h automatic-recording grating spectrometer are ed in tabular and graphical form. A photo- of a recorded spectrogram provides an indi- of the quality of the data. A comparison of erimental results with figures based on accepted of the molecular constants shows substantial ent.

A.

535.343.4–15

Note on the infrared absorption of the flame nple double-base powder. H. F. WHITE, G. R. , D. ROTENBERG AND B. CRAWFORD, JR. in *J. chem. Phys.*, **21**, 1399 (*Aug.*, 1953).

powder was burned under a pressure of 140 lb/in.^{2}, 8 or 9 strong bands being found between 1250 and 4000 cm^{-1}. Only one at 2349 cm^{-1} has been assigned to CO_2.

C. TURNER

535.343.4–15 : 539.133

7580. Rotation vibration bands of some symmetric top molecules under high resolution. T. A. WIGGINS, E. R. SHULL AND D. H. RANK. *J. chem. Phys.*, **21**, 1368–73 (*Aug.*, 1953).

The fine structure of some parallel bands of the symmetric top molecules CH_3I, CD_3Br, CHF_3 and $CHCl_3$ has been investigated in the 1·6 and 2·2 μ regions. The double-pass plane grating spectrograph was capable of achieving a resolving power in excess of 100 000. For most of these bands the "line" nature of the sub-bands in the *P*, *Q* and *R* branches was demonstrated. In the case of CH_3I the resolution was complete enough to demonstrate conclusively the complicated fine structure of the *P* and *R* "lines." Molecular constants have been derived from the bands of CH_3I, CD_3Br and CHF_3. The theoretically expected relationship between the zeta's has been shown to hold in perpendicular CH_3I bands.

A.

535.343.4–15 : 539.133

7581. The vibration spectrum of nitrous oxide in the neighbourhood of 4 μ. G. AMAT, P. BARCHEWITZ, M-L. GRENIER-BESSON. *C.R. Acad. Sci.* [*Paris*] **237**, 145–6 (*July* 15, 1953) *In French.*

The band 4 ν_2 has been found superimposed on the fine structure of the ν_3-band of atmospheric CO_2. The centre lies at 2365·8 cm^{-1}. This does not agree with Herzbergs' [Abstr. 2548 (1951)] theoretical values, because the latter does not take account of the Fermi–Dennison resonance which results from the accidental degeneration of the levels.

C. TURNER

535.345.1–32 : 539.234

7582. Thin transparent films in the far ultraviolet. N. ASTOIN AND B. VODAR. Letter in *J. Phys. Radium*, **14**, 424–5 (*June*, 1953) *In French.*

Vacuum-tight films of Al and SiO formed by evaporation are transparent in the regions 150–400 Å and 150–1200 Å respectively. Density-wavelength curves are given.

G. F. LOTHIAN

535.37

7583. Change of dielectric constant on illumination, ferro-electricity, and thermoluminescence in zinc oxide irradiated in the ultraviolet. J. ROUX. *C.R. Acad. Sci.* [*Paris*] **236**, 2492–4 (*June* 29, 1953) *In French.*

If a thin layer of "analytical quality" ZnO is illuminated in the ultraviolet there is a feeble greenish fluorescence, but no phosphorescence. If the layer is heated to 200°C there is a burst of greenish light about one minute after the u.v. irradiation. This suggests the presence of electron traps, and the large "photo-dielectric" effect observed suggests polarization of the traps upon trapping electrons.

C. A. HOGARTH

535.37

7584. Monolayer fluorescent screens. L. R. KOLLER. Letter in *J. Opt. Soc. Amer.*, **43**, 620 (*July*, 1953).

A single layer of closely packed phosphor grains may be more efficient under cathode rays than the usual settled screen. The powder was coated with a water-repellent silicone, floated on to water, compressed on the surface by sliding barriers, and

removed by raising a glass support from below. The open area in the layer ranges from 10 to 30%.

S. T. HENDERSON

535.371

7585. Kinetics of phosphorescence. V. V. ANTONOV-ROMANOVSKIĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 517–20 (1952) *In Russian.*

Two basic causes for the deviation of the experimental decay curves for phosphors from the theoretically predicted 2nd-order hyperbolic form (bimolecular recombination reaction) are considered to be (*a*) initial non-equilibrium distribution of electrons among the possible levels in the phosphor, and (*b*) the fact that the radius of the sphere of capture for an electron around an ionization centre of luminescence is $\sim 10\times$ the radius of the recombination sphere. The fact, reported by Vinokurov (abstract following) that continuous irradiation of a phosphor with infrared light rapidly converts its decay curve from the usual complex form to the simpler one predicted by theory can be explained in terms of the elimination of these effects by i.r. illumination. R. C. MURRAY

535.371

7586. Thermal and infra-red extinction of a ZnS–Cu, Co phosphor. L. A. VINOKUROV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 529–32 (1952) *In Russian.*

Two mechanisms for extinction are described: (I) or internal, in which electrons, having fallen into the excitation levels of the ionization centres of luminescence, fall to a lower level of the activator without radiation, and (II), or external, whereby electron "holes" in the lowest filled level of the ground state of the ionization centres unite with free electrons from the conductivity zone, or with electrons at the capture levels: I does not affect the form of the decay curve, whereas II changes it from a hyperbolic to an exponential form. The change in form of the decay curves for the phosphor between 100 and 175°C indicates operation of type II extinction at higher temperatures, whereas the fact that irradiation of the material with i.r. light of different intensities does not change the form of the decay curve, but only shifts it nearer to the coordinate origin, in proportion to the i.r. intensity, indicates the presence of type I extinction and suggests that the function of the i.r. light is to eject electrons from the capture levels. The theory is used to explain the experimental observation that, when a phosphor is first irradiated with i.r. some time after the exciting source has been extinguished, there is actually a large initial increase of luminosity followed by further, and more rapid, decay.

R. C. MURRAY

535.371

7587. Phosphors on a basis of magnesium arsenate, activated by manganese. T. S. DOBROLYUBSKAYA. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 537–8 (1952) *In Russian.*

Compounds of the formula $n\mathrm{MgO} \cdot \mathrm{As_2O_5}$, activated by 0·02 mol. of Mn, excited by light of 3650 Å, emitted a bright red luminescence of max. brightness at $n = 10$, falling to a constant level of ½ the max. brightness when $n = 12$–15. The luminescence spectrum consists of 1 sharp band (centre at 6400 Å) and 4 diffuse bands on either side (centres at 6230, 6290, 6500 and 6570 Å), little affected by r… temperature to 200°C, and practically iden… those given by Mg germanate [Abstr. 183… and agreeing with those of Travnicek *et al.* after the paper was written [Abstr. 3480 (1… use for these phosphors for correcting the li… of Hg lamps at high and very high pre… envisaged. R. C.

7588. Fluorescence of ions and atomic c… copper in NaCl–Cu phosphors. M. L. KAT… *Akad. Nauk SSSR*, **85**, *No.* 4, 757–60 (… *Russian.*

The effect of prior irradiation of NaCl–… phors (containing CuCl) with X-rays on th… quent fluorescence was investigated. N… irradiation of these with light of λ_{mx} = … selectively absorbed by Cu^+ ions, excites … violet fluorescence; when the phosphor is … to prior irradiation with X-rays the intensit… fluorescence falls with increase in the tim… irradiation to a limiting intensity about 1/3r… for no prior irradiation; there is a concomitant… (from zero) in intensity of a very stable oran… and red fluorescence, excited by two new… with maxima at 300 mμ (*A* centres) and … (*A′* centres). The fluorescence is weaker th… obtained in NaCl–Ag phosphors, and the c… CuCl concentration is 0·1 mol %. The e… irradiation by X-rays is explained in terms o… version of some, but not all, the Cu^+ ce… atomic Cu centres: in the *A* centres, only the… ions adjacent to halide vacancies can be se… formed. R. C.

7589. Study of some optical properties … (Pb, Sm) and CaO (Pb, Pr). A. CROZET, J. … AND J. JANIN. *J. Phys. Radium*, **14**, 12S–13S… 1953) *In French.*

The effect of small concentrations of Pb on … or CaO–Sm phosphors is investigated. The e… bands due to Pr and Sm are enhanced and … due to Pb appears at 3450–4000 Å. Phosphor… excitation spectra have bands at 3700, 34… 2850 Å. The influence of Pb is greater in … than in CaO–Sm. Stimulation spectra show … at 1·3 μ and one nearer to the visible region.

G. F. J. G…

7590. The determination of the fluorescen… times of dissolved substances by a phase shift m… E. A. BAILEY, JR, AND G. K. ROLLEFSON. *J. … Phys.*, **21**, 1315–22 (*Aug.*, 1953).

The lifetimes of fluorescent substances are … mined by exciting the fluorescence with light … lated at a high frequency and measuring the diff… in phase between the exciting light and the re… fluorescence. The exciting light is modulated … ultrasonic standing wave in a liquid which cau… latter to act as an intermittent diffraction g… Photomultiplier tubes are used to pick up the e… and fluorescent light. Tuned circuits are u… isolate a single harmonic of the signal from the … tubes and the phase shift determined by comp…

a calibrated phase shifting circuit. The phase ϕ is related to the lifetime by $\tan\phi = \omega\tau$ (in ω is 2π times the frequency of modulation is the lifetime of the excited state). The data that lifetimes can be determined with a precision to 2×10^{-10} sec. The lifetimes of acridone in ul solution (saturated to 10% saturated) and ne sulphate (4×10^{-6} to 4×10^{-5}M) in 0·01 M acid are independent of the concentration. The found are: acridone $1\cdot59 \pm 0\cdot01\times10^{-8}$ sec, quinine sulphate $2\cdot28\times0\cdot02\times10^{-8}$ sec. The ne of fluorescein in 0·005M potassium hydroxide ses with concentration over the range 10^{-6} to $^{-4}$M. This fact can be explained by assuming ome of the fluorescent light is absorbed and itted. The lifetime of fluorescein extrapolated o concentration is $4\cdot5 \pm 0\cdot1\times10^{-9}$ sec. A.

535.371

The storage of energy in silver activated ium chloride. C. E. MANDEVILLE AND H. O. ECHT. *Phys. Rev.*, **91**, 566–7 (*Aug.* 1, 1953).

rstals of KCl–Ag and NaCl–Ag have been d by X-ray irradiation. The photostimulated yield of the ultraviolet emission band has been ved simultaneously with application of the lating near-ultraviolet light. The decay with of the stored energy in the two phosphors is ared. A.

535.371

The scintillation process in plastic solid ons. R. K. SWANK AND W. L. BUCK. *Phys.* **91**, 927–33 (*Aug.* 15, 1953).

e scintillation process has been studied in a er of systems involving a solid solution of an ic fluor in polystyrene or polyvinyltoluene. It been determined that direct excitation of the by the ionizing radiation contributes a neg- e amount to the observed scintillation for the ntrations studied. Fluorescence of the solvent ved by radiative transfer to the solute is a icant process, but the major fraction of the llation, in the more efficient systems, is trans- l from the solvent to the solute by a non- tive process. Comparison of optical data with of pulse size *v.* concentration points to dipole- e interaction as a means of energy transfer. parison of results with α- and β-particles shows the same degree of quenching is present in the nt for both types of excitation. A.

535.375.5

Photoelectric recording of Raman spectra in ized light. YA. S. BOBOVICH AND D. B. GURE- *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 521–4) *In Russian.*

ght from two arch-form lamps is passed through oid (hepatite) film filters formed into tubes unding the cuvette of solution; exposures are first with the parallel and then with the per- icular component of the polarized light incident e solution, by suitable disposition of the filters. being scattered from the cuvette, the light passes an entry collimator 7·5 cm dia., and of 50 cm length, and falls on to a grating $8\times7\cdot5$ cm^2 with 600 lines/mm (concentration of energy in of the 2nd orders at 4359 Å is 60%). The linear dispersion in the 2nd-order spectra is 8 Å/mm. Scanning is effected by rotation of the grating, connected to the recording drum through a reducing gear; light reaches the latter from the grating after passage through a photomultiplier (fed at 1000 V and having an integral sensitivity of 30 A/lumen, and a dark current of $2\cdot2\times10^{-9}$ A) and reflection from the mirror of a galvanometer of sensitivity 4×10^{-8} A. The linear calibration curve for correcting the observed to the true degree of depolarization is reproduced, along with an example of a record of a Raman spectrum for CCl_4. R. C. MURRAY

535.375.5

7594. Optical method of investigating silico-organic hydrocarbons. Raman spectra of alkenyl silanes. YU. P. EGOROV AND P. A. BAZHULIN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 4, 647–50 (1953) *In Russian.*

535.375.5

7595. The widening with increasing temperature of the Raman bands of water in gypsum. R. AYNARD. *C.R. Acad. Sci.* [*Paris*] **236**, 1416 (*April* 8, 1953) *In French.*

Observations are recorded on the Raman bands of water in gypsum between room temperature and 120°C. The widening observed is thought to be due to the increasing mobility of the water molecules.

G. I. W. LLEWELYN

535.375.54 : 535.372

7596. Raman spectrum and cathodo-luminescence spectrum of aluminium phosphate. B. D. SAKSENA AND L. M. PANT. Letter in *J. chem. Phys.*, **21**, 1414 (*Aug.*, 1953).

The spectra are figuratively represented. Previous data indicate that the lattice structure of $AlPO_4$ closely resembles that of SiO_2 but the spectra now recorded for $AlPO_4$ show considerable deviation from the corresponding spectra of α quartz.

G. I. W. LLEWELYN

535.375.54 : 548.7

7597. Raman spectrum of the water of crystallization of $HgCl_4K_2 . H_2O$. A. WEIL. *C.R. Acad. Sci.* [*Paris*] **236**, 2147–9 (*June* 1, 1953) *In French.*

535.375.55

7598. On the Raman spectra of thianthrene in various solutions. S. K. MUKERJI AND B. LAL. *Nuovo Cimento*, **9**, 699–704 (*Aug.*, 1952).

The Raman spectra of thianthrene have been studied in solutions of CS_2, CCl_4, chloroform, etc. A few lines which appeared in the solid state but did not appear in the molten state, have appeared in solutions, and some have undergone changes of intensity in different solutions. The very low frequency lines which appeared in the solid state, have not appeared in the molten state nor in solutions, thus lending support to the view that these lines are due to the oscillations of the lattice. The largest of Raman lines have been observed in CS_2 solution. They are at 158(4), 220(4), 305(4), 380(3), 490(4), 552(4), 592(6), 680(1), 744(4), 1033(10), 1123(10), 1275(6), 1563(8), 2225(4) and 3044(6) cm^{-1} respectively. The results obtained in the various solutions are compared with one another and also with those already obtained by the authors in the solid and molten

states, and the changes in frequencies in different states are discussed. A.

535.375.55

7599. On the technique of the Raman effect of resinic acids and of their derivatives. LE-VAN-THOI. *C.R. Acad. Sci.* [*Paris*] **236,** 2496–8 (*June* 29, 1953) *In French.*

At concentrations greater than 20%, the Rayleigh scattering of optically pure solutions of hydrophenanthrene carboxylic acids and their derivatives in $CHCl_3$ and CCl_4 increases very rapidly with concentration. Using solutions of concentrations <20%, the Raman spectra of a series of these compounds have been determined using the indigo Hg line, thus enabling characterization of compounds of known structure and elucidation of the structure of several new derivatives. G. I. W. LLEWELYN

535.375.56

7600. The rotational Raman spectrum of benzene vapour. B. STOICHEFF. Letter in *J. chem. Phys.*, **21,** 1410–11 (*Aug.*, 1953).

The pure rotational Raman spectrum of benzene vapour excited by the Hg 4358 line at 61°C at a pressure of ½ atm. has been photographed, using an apparatus of resolving power 100 000. The moment of inertia of C_6H_6 about an axis in the plane of the molecule is calculated to be $(147{\cdot}64 \times 0{\cdot}04) \times 10^{-40}$ g.cm^2 and the ranges of compatible values of C–C and C–H bond distances are suggested, assuming the D_{6h} structure. G. I. W. LLEWELYN

535.376

7601. Scintillations of α-particles in CsI. B. HAHN AND J. ROSSEL. *Helv. phys. Acta.*, **26,** *No.* 3–4, 271–80 (1953) *In French.*

An investigation of the scintillations produced by α-particles in monocrystals of CsI (without activator) has been made. At 77°K the measured decay-time τ of the scintillations is 0·5 μsec. Near 135°K at increasing temperatures the observed exponential decay goes over into a more complex decay law. By comparison with ZnS(Ag) as well as with anthracene an absolute luminescence efficiency e_l of about 35% was found. A scintillation spectrometer with a CsI crystal and an RCA Photomultiplier 5819 exhibits a width of 5·5% for the α-line of Po^{210}; 80% of this width arises from the multiplier. Still better resolution can be expected. A.

535.376

7602. Excitation of luminescence by variable electric fields: primary effect. G. DESTRIAU. *J. Phys. Radium*, **14,** 307–10 (*May*, 1953) *In French.*

It is shown experimentally that the production of luminescence in phosphors by application of alternating electric fields is a primary effect and is not due to excitation by discharges in residual gas in the phosphor layer. G. F. J. GARLICK

535.39 : 551.578.4

7603. The luminous directional reflectance of snow. A. W. CHRISTIE. Letter in *J. Opt. Soc. Amer.*, **43,** 621–2 (*July*, 1953).

Middleton and Mungall's recent work [Abstr. 7199 (1952)] is examined, and a general expression derived for the fraction of light reflected by an aggregate of small surfaces whose normals point in random directions. The limiting conditions (particular involving a small source and small receiver cussed at some length, as these are of prac portance (e.g. to aircraft pilots) and there difficulty in interpreting observations ma goniometers of small dimensions. Similar occur in street lighting studies of road surfac R.

7604. Reflection spectra of ordinary and e lead glasses in the infrared range. V. A. FLOR *Dokl. Akad. Nauk SSSR*, **89,** *No.* 2, 261– *In Russian.*

7605. Measurements of reflecting powers metallic films (rhodium, beryllium, nickel) Schumann region. S. ROBIN. Letter in *Radium*, **14,** 427–8 (*June*, 1953) *In French.*

Continuation of earlier work [see Abst (1953)]. Curves show reflections at inciden of 18° and 45°, in the range 1200–2000 Å. tions confirm electromagnetic theory. G. F. J

7606. Electronic location of interference J. PETERS AND G. STROKE. *J. Opt. Soc. Am* 668–72 (*Aug.*, 1953).

A device is described which determines reference position in terms of interference frin measures any shift to a small fraction of a fri can be used with static or slowly moving fring is based on the principle of superposition images of the fringe pattern in polarized light single slit of a photomultiplier tube. By mea rotating Polaroid as optical shutter an alte signal is produced of which the amplitude an are a function of the displacement.

7607. On the theory of a multiple etalon (mul F. A. KOROLEV. *Dokl. Akad. Nauk SSSR*, **88,** 651–2 (1953) *In Russian.*

Examines the relation between resolving pow dispersive power of a pair of etalons in series used to examine intensity and separation of hyp structure. W. BAR

7608. Resolving power of the Fabry–Perot M. S. SODHA. Letter in *Curr. Sci.*, **22,** 139–40 1953).

The Rayleigh, Sparrow and Abbe criteri resolution are applied respectively to the case prism, the line grating and the Fabry–Perot inte meter. In the case of the Fabry–Perot instr there is a large difference between the calc resolution criteria. The three different assum lead to resolution separations in the ratios 2·72 : 2·08. Thus this interferometer is i suited for deciding between the validity of the different criteria. S. TOLA

7609. Selection of optimal spacers in Perot– **interferometry.** G. V. DEVERALL, K. W. MEI AND G. J. ZISSIS. *J. Opt. Soc. Amer.*, **43,** 6 (*Aug.*, 1953).

Contains a general discussion of the condition

ıl separation of Perot–Fabry patterns. A con-t graphical method is given which permits the ɔn of the proper spacer thicknesses for the clear ion of the components of a pattern even in icated cases. A.

535.417 : 536.2

:h–Zehnder interferometer applications as used study of convection and conduction heat-transfer s. *See Abstr.* 7620

535.422

Diffraction of spherical vector waves by an half-plane. K. L. McDONALD. *J. Opt. Soc.* **43,** 641–7 (*Aug.*, 1953).

nsion of an earlier publication [Abstr. 5705]. The present treatment pertains to the vector ield. A new expression is given for the case of magnetic waves emitted by a simple harmonic an oscillator and diffracted by a thin black half-plane immersed in a homogeneous and ɔic medium. By use of Maggi's transformation oblem is reduced to the evaluation of two ıls. Both integrals are approximated by the method used in the scalar treatment. Two ılar orientations of the oscillator are con-d, and the six field components are written out ch case in terms of Fresnel integrals. Energy relative intensity distribution and polarization cussed. The relative intensity is shown to agree calar predictions in the region of the shadow-ary-plane, and therefore with experiment. The tor is infinitely removed from the diffracting thereby allowing a comparison of the black with Sommerfeld's perfectly reflecting screen. A.

535.43

The line width of Rayleigh scattering in a gas. ɔBEL'MAN. *Dokl. Akad. Nauk SSSR*, **88,** *No.* 4, (1953) *In Russian.*

etailed quantum mechanical examination of the ing of an individual molecule in the case of on and impulse extinction of its eigenvibrations. h cases this extinction does not express itself in e width of coherent Rayleigh scattering.

J. JACOBS

535.43

Scatter fringes of equal thickness. J. M. ı. Letter in *Nature* [*London*] **171,** 889–90 16, 1953).

ɔptical arrangement is described which leads to mation of white light fringes of equal thickness ɔed by a scattering system. Some properties of nges are briefly indicated. The fringes have advantages, not losing contrast in the presence or asphericity. Their use for testing large s, lenses and interference microscopy is ɔred. S. TOLANSKY

535.43 : 548.7

Experimental results of a study of the scatter-light by natural and synthetic crystals of sodium e. L. TAUREL AND G. CHAMPIER. *C.R. Acad. ıris*] **236,** 1549–51 (*April* 20, 1953) *In French.*

ı the same incident angles as in Abstr. 8099 and with a photomultiplier cell, the scattering ɔn measured in synthetic crystals cut from the ingle crystal. The scattering is not identical, but does not differ so much as for two non-related crystals. For natural crystals the scattering is of the same order as for synthetic ones, and is different for different specimens. C. TURNER

535.434

7614. Rayleigh's ratio (absolute turbidity levels) for benzene, carbon tetrachloride, and toluene. R. F. STAMM AND P. A. BUTTON. Letter in *J. chem. Phys.*, **21,** 1304–5 (*July*, 1953).

Experimental values for Rayleigh's ratio at 25°C are tabulated. A brief description of the apparatus used is given. G. I. W. LLEWELYN

535.434 : 541.64

7615. Scattering factors for certain polydisperse systems. M. GOLDSTEIN. *J. chem. Phys.*, **21,** 1255–8 (*July*, 1953).

Scattering functions for systems of polydisperse rods are calculated. The reciprocal scattering functions are found to have a greater downward curvature the greater the polydispersity. It is shown that this increased curvature is a property of polydisperse systems under very broad conditions. A.

535.55

7616. Study of isochromatic lines in transparent models undergoing finite plastic deformations. S. I. GUBKIN AND S. I. DOBROVOL'SKIĬ. *Dokl. Akad. Nauk SSSR*, **88,** *No.* 5, 799–802 (1953) *In Russian.*

The shape of isochromes is shown not to depend excessively on the type of material investigated (elastic, elasto-plastic, plastic such as silver chloride, and highly plastic). In the case of a punch pressed against a side of a rectangular flat model, isochromes represent circles passing through the edges of the punch when the model is elastic or elasto-plastic, ellipses when the model is highly plastic or plastic, and may even disappear in the latter case if the polycrystalline plastic material has large grains. This behaviour is explained by analysing in each case the predominating type of residual stresses. It is concluded that models for investigating stress distribution in polycrystalline metals subjected to plastic deformation should be made of amorphous highly plastic materials. In some cases it is also possible to use elasto-plastic materials which can be subjected to large elastic deformations. A. GELBTUCH

535.55

7617. On the Tardy and Sénarmont methods of measuring fractional relative retardations. H. T. JESSOP. *Brit. J. appl. Phys.*, **4,** 138–40 (*May*, 1953).

An investigation into the errors in measurements by the Tardy and Sénarmont methods shows: (i) that the errors due to inaccurate quarter-wave plates are less in the Sénarmont method than in the Tardy, (ii) that errors due to inaccurate setting of the polaroids are of the same order in both methods, and (iii) that in general the error in the final setting of the analyser is the only one which need be considered. A full account is given of the less well-known Sénarmont method. A.

535.58

7618. Study of the dispersion of birefringence of cellophane in the visible spectrum. R. SARDOS. *J. Phys. Radium*, **14,** 21S–22S (*May*, 1953) *In French.*

Cellophane sheets, 0·02 mm thick, in which multiple

reflections were eliminated by mounting in oil between two glass disks, were studied in the wavelength range 4000–6300 Å. The results are presented graphically and appear to satisfy the equation given by Servant [Abstr. 3516 (1952)]. H. G. JERRARD

535.7 : 612.84

Physiological optics. *See Abstr.* 8141–8

535.824

7619. The use of a microscope with large working distance in the study of atomizing jets. F. FERRIÉ, R. EDDI, S. K. BANERJEA AND N. MANSON. *C.R. Acad. Sci.* [*Paris*] **237,** 233–5 (*July* 20, 1953) *In French.*

Previous apparatus has been limited by the short working distance of the microscope, so that jets in combustion have not been observable. An optical arrangement having a working distance of 114 mm is described, which gives a larger visible region and minimizes errors due to variations of magnification. The application to a gas turbine injector is briefly described. R. W. FISH

HEAT 536

536.2 : 535.417

7620. Mach–Zehnder interferometer applications as used in the study of convection and conduction heat-transfer systems. C. D. COULBERT. *Mech. Engng,* **74,** 1005–10 (*Dec.*, 1952).

A review is given of the experimental arrangement. Applications to heat flow round cylinders and plates are illustrated and the evaluation of the interferograms is described. Technological applications (e.g. heat flow round riveted angle-joint) are illustrated. Transition from free to forced convection is demonstrated with one-inch and one-twentieth-inch diameter cylinders. The use of the instrument specifically as a temperature measuring device is discussed in detail.

S. TOLANSKY

536.21 : 537.312.62

Heat conductivities of superconductive Sn, In, Tl, Ta, Cb, and Al below 1°K. *See Abstr.* 7688

536.212.2 : 537.311.31

7621. The thermal and electrical conductivities of beryllium. R. W. POWELL. *Phil. Mag.*, **44,** 645–63 (*June*, 1953).

Several samples of metallic beryllium have been studied. Heat treatment to temperatures of the order of 700°C invariably caused increases in the thermal and electrical conductivities and determinations of these two properties have been made for both as received and heat treated states. For the most part the thermal conductivity measurements were limited to the range 50° to 350°C, but in one instance these measurements were extended to 700°C. The thermal conductivity is found to have a large negative temperature coefficient, in contrast to the only previous measurements recorded above room temperature which had yielded a positive temperature coefficient. Much of the abnormal nature of the temperature variation of the Lorenz function of beryllium which these results of Lewis (1929) had indicated now disappears. The equation suggested for the derivation of the thermal conductivity of a sample of beryllium from a knowledge of its electrical res

$$K = 10^{-8}\frac{T}{\rho}\left(2{\cdot}57 - \frac{249}{T}\right) + \frac{268}{T} - (\ldots$$

This equation fits the present results to … to +5%. It could probably be applied … peratures above 400°C, but now below 0… further investigation is considered necessary…

7622. Experimental study of convect… moving walls. C. BORY. *C.R. Acad. Sci.* [*P*… 2306–8 (*June* 15, 1953) *In French.*

A short note on the convective heat los… heated surface moving within a wind tun… movement disturbs the velocity field in a… manner and the rate of heat loss is increased… E…

7623. Thermal expansion of zirconium … 298°K and 1600°K. G. B. SKINNER AND H. … STON. *J. chem. Phys.*, **21,** 1383–4 (*Aug.*, 195…

The average coefficients of thermal expa… hexagonal zirconium between 298°K and 11… $5{\cdot}5\times10^{-6}$ deg^{-1} along the *a* axis, $10{\cdot}8\times10$… along the *c* axis, and $7{\cdot}2\times10^{-6}$ deg^{-1} for a r… oriented polycrystalline sample. The average… the linear coefficient of expansion of cubic z… between 1143°K and 1600°K is $9{\cdot}7\times10^{-6}$ de… the transition there is a decrease in volume o…

536.413.2 :

7624. Thermal expansion anomalies of ferro… rare earth metals: gadolinium and dys… F. TROMBE AND M. FOËX. *J. Rech. Cent. Na… Sci.*, **5,** 71–5 (*June*, 1953) *In French.*

Describes measurements of $\Delta l/l$ as a fun… temperature up to about 700°K. The resu… been summarized previously [Abstr. 811… (1952)]. New results are presented for … lanthanum and neodymium, where temp… anomalies (thermal hysteresis effects) are not… able to magnetic transformations. E. P. WOH…

536

7625. Method of calculating the vapour pre… water between 0° and 100°C. J.-P. E. DU… *C.R. Acad. Sci.* [*Paris*] **236,** 2041–3 (*May* 27… *In French.*

Points out that the usually accepted valu… a compromise between two sets of data, and … thermodynamic formula from which the … pressure can be calculated. L. G. CAR…

536

7626. The vapor pressures of the deuterome… G. T. ARMSTRONG, F. G. BRICKWEDDE AND … SCOTT. Letter in *J. chem. Phys.*, **21,** 1297–8… 1953).

A preliminary report of a recent recalculat… measurements made at the National Bure… Standards some years ago on samples of … deuteromethanes (CH_3D, CH_2D_2, CHD_3 and … The following values are tabulated: (1) *A* and … both the liquid and solid range) for the relati…

$P_H = A - B/T$, (2) the triple-point temperature, and (3) the triple-point pressure.

F. LACHMAN

536.46

Flames: their structure radiation and temperature. A. G. GAYDON AND H. G. WOLFHARD. *Chapman and Hall* (1953) 340 *pp.*

Comprehensive treatment of the physics of flames. Topics discussed in detail include: of measurement of burning velocity, the ism of flame propagation, solid carbon formation, stable and polyhedral flames, radiation and ion in flames, and the measurement and tion of flame temperatures. A brief outline is the problems considered by the authors to it the most profitable lines for further investigation; these include a more detailed study of ture of the reaction zone and the elucidation cause of abnormally high electronic excitation ng in the reaction zone of most inorganic A bibliography of about 400 references is

A. SCHOFIELD

536.46

Stabilized cellular flames. H. GUÉNOCHE JOUY. *C.R. Acad. Sci.* [*Paris*] **236,** 2295–7 (1953) *In French.*

Front of a flame, during propagation, exhibits vibrations due to vibratory phenomena associated combustion in an enclosure; in a tube, when the front enters its vibratory phase the flame-front flattens and the flame straightens out. The effect of vibrations upon the flame front can be of two kinds: (1) when the amplitude of the vibrations greater than a certain value, a_0, the combustion vibrates while maintaining an even surface; (2) the amplitude of vibration exceeds a_0, the flame front is composed of a number of very small combustion waves. Amplitude conditions independent upon spatial conditions, determined by position of the flame. Deformation of the flame by waves of small amplitude enables a flame stabilized in a gas stream supplied at low to a cylindrical tube, without the use of to stop the flame, but such stabilization is only in a definite region of the tube. It can demonstrated by the combustion of certain rich mixtures, producing cellular flames in a tube, and by the combustion of weak mixtures same two gases, provided vibrations are produced artificially in the gas stream. Details of the phenon are studied. J. S. G. THOMAS

536.46 : 537.534.72 : 541.124

The detection of atoms and free radicals in by mass spectrometric techniques. S. N. FONER L. HUDSON. *J. chem. Phys.*, **21,** 1374–82 (1953).

Mass spectrometric method employing a molecular gas sampling system has been developed detection of atoms and radicals in chemical Background signals have been virtually ed by mechanically modulating the molecular d applying phase detection to the ion signal. plication of the method is illustrated by s of low-pressure flames. In the hydrogen-oxygen flame H, O and OH have been positively identified. The mass spectrum of a simple hydrocarbon flame, such as the methane-oxygen flame, is complicated by the presence of a large number of stable components generated in the flame. In the methane-oxygen flame the stable intermediates include C_2H_2, CO, CH_2O or C_2H_6, CH_4O and C_4H_2. The methyl radical has been clearly identified in the methane-oxygen flame. A search for the HO_2 radical in the hydrogen-oxygen flame was made without obtaining positive results. The HO_2 detection problem is discussed in detail. A.

536.48

7630. Cerium magnesium nitrate. I. The magnetic properties and specific heat above 1°K. A. H. COOKE, H. J. DUFFUS AND W. P. WOLF. *Phil. Mag.*, **44,** 623–9 (*June*, 1953).

The magnetic properties and specific heat of cerium magnesium nitrate have been measured at temperatures between 1°K and 4·2°K. The magnetic properties can be described by a highly anisotropic g-tensor, having a very small value along the crystalline axis and a value of 1·84 perpendicular to it. The specific heat is extremely small, being given in this range of temperatures by $C_I = 7{\cdot}5 \times 10^{-6} R/T^2$. It is shown that the specific heat can be accounted for almost entirely by magnetic dipole–dipole interaction. The use of the salt for work below 1°K is discussed. A.

536.48

7631. Cerium magnesium nitrate. II. Determination of the entropy—absolute temperature relation below 1°K. J. M. DANIELS AND F. N. H. ROBINSON. *Phil. Mag.*, **44,** 630–5 (*June*, 1953).

The entropy of cerium magnesium nitrate as a function of absolute temperature and the relation between the magnetic temperature and absolute temperature below 1°K have been determined by adiabatic demagnetization experiments. The absolute temperature is almost constant and equal to 3·08 millidegrees for $S/R < 0{\cdot}45$. Above 6 millidegrees $T = T^*$. The results for lower temperatures are given in the form of a table. A.

536.48

7632. The thermal conductivity of solid helium at high densities. F. J. WEBB AND J. WILKS. *Phil. Mag.*, **44,** 664–74 (*June*, 1953).

Earlier measurements of the thermal conductivity of solid helium [Abstr. 8836 (1952)] have been extended to higher densities by using pressures up to 1800 atmospheres. Values of the conductivity are now available for densities from 0·19 to 0·35 g/cm^3, corresponding to a range of Debye characteristic temperatures (24° to 90°) which is sufficient to cause the measured conductivities at a given temperature to vary by a factor of over 300. Below a density of 0·28 g/cm^3 the present results are in substantial agreement with the discussion given previously; at higher densities the results are irregular. A.

536.48 : 536.631

7633. The specific heat of beryllium at low temperatures. R. W. HILL AND P. L. SMITH. *Phil. Mag.*, **44,** 636–44 (*June*, 1953).

Measurements have been made in the temperature

range 4 to 300°K. The results obtained are consistent with the most recent high temperature data, but are markedly different from existing low temperature ones. In particular, no trace of anomalous behaviour near 11°K was found, and the low temperature results have been analysed to yield an electronic specific heat of $5{\cdot}4\times10^{-5}\,T$ cal deg^{-1} g atom^{-1}, in good agreement with theoretical predictions. The Debye characteristic temperature is constant at 1160° below 20°K, but falls with increasing temperature to 925° at 300°K; this behaviour is believed to be characteristic of the close-packed hexagonal lattice. Values are also given for the heat capacity of a bakelite varnish used in these experiments. A.

536.48 : 539.166

7634. On the use of γ-rays in low temperature calorimetry. N. Kurti and F. E. Simon. *Phil. Mag.*, **44**, 501–3 (*May*, 1953).

The effects due to delayed heat evolution that might accompany γ-ray absorption in crystals are discussed. It is concluded that, at least in the experimental conditions and with the substances employed so far, γ-ray heating is a reliable method for use in calorimetry in the "magnetic" temperature region. A.

536.48 : 539.166

On the "heating" resulting from the absorption of gamma-rays at extremely low temperatures. *See Abstr.* 7897

536.48

7635. Bose–Einstein condensation in helium films. J. M. Ziman. *Phil. Mag.*, **44**, 548–58 (*May*, 1953).

It is shown that an ideal Bose–Einstein gas confined to a layer of any finite thickness behaves like a "two-dimensional gas" in that the temperature of the B.E. condensation is size-dependent and tends to zero as the area of the layer tends to infinity. Such an effect is not observed in real helium films. If it is assumed that liquid He must be treated as if made up of independent B.E. assemblies, each smaller than a fixed length L_0 ($\sim 7\times10^{-6}$ cm), the observed variation, with thickness, of the temperature of onset of superfluidity, in unsaturated films, may be closely predicted. The zero-point motion in each restricted assembly is then close to the critical transfer velocity of superflow, and L_0 is of the same order of magnitude as the thickness of the saturated film. This assumption brings the ideal B.E. gas model nearer to the real structure of liquid He, but the interpretation of L_0 as a "scattering length" does not give agreement with estimates from kinetic theory. A.

536.48 : 541.183

7636. The adsorption of gases at high saturations. II. The thickness of the unsaturated helium film. R. Bowers. *Phil. Mag.*, **44**, 485–96 (*May*, 1953).

For Pt I, see Abstr. 8033 (1953). The adsorption of helium on an aluminium foil has been measured between 1·8°K and 4·2°K. The principal interest was in the form of an isotherm close to saturation. The maximum thickness observed for the adsorbed layer at the highest saturations (greater than 99·9%) was twenty atomic layers below the λ-point and ten layers above the λ-point. These values for the unsaturated film are compared with existing data for the thickness of the saturated helium II film. The data are a compared with the Frenkel–Halsey–Hill equation multilayer adsorption and the calculations of Band the adsorption of a Bose–Einstein gas.

536.

7637. Heat transfer in liquid helium II through extremely fine slit. T. Inoue. *J. Phys. Soc. Japan*, 450–4 (*July–Aug.*, 1953).

Assuming a film of pure superfluid on the wall an introducing a mutual friction somewhat different fro that suggested by Gorter, the heat conductivity calculated on the basis of the two-fluid model an internal convection. The formula for the heat con ductivity shows a fairly good agreement with th experiments, including the case of very narrow slit The London–Zilsel's formula is also included as special case. In very narrow slits, the heat con ductivity approximates to $\langle K\rangle = s_\lambda{}^2T^{r+1}d/2BT_\lambda$. (is absolute temperature, d slit width, T_λ transitio temperature, s_λ entropy per gram at T_λ, r numerica constant $5{\cdot}5 \sim 5{\cdot}6$, B the quantity related to th film and the mutual friction.) At a temperature nea T_λ, $\langle K\rangle$ is approximately $s_\lambda^2/A_1T_\lambda^{2r}\,.\,(T_\lambda^r - T^r)T^{r+1}$ where A_1 is the quantity related to mutual friction At intermediate slit width and temperature, $\langle K$ approximates to the London–Zilsel's formula. B, A and critical velocity are discussed and the numerica values calculated. A

536.53

7638. A method for measuring the spectral reflectivity of a thermopile. E. J. Gillham. *Brit. J. appl. Phys.*, **4**, 151–5 (*May*, 1953).

A method of measuring the reflectivity of a thermopile is described in which the reflected radiation is refocused back on to the thermopile by means of a spherical mirror. A specially constructed thermopile, incorporating an electrical heating element, was used, so that the contribution of thermal radiation to the apparent reflectivity could be determined. The spectral reflectivity of this thermopile has been measured in the wavelength range extending from the visible to 13 μ, and the relative sensitivity values so obtained used to establish accurate standards for the measurement of monochromatic radiation in this region. Various sources of error are discussed, in particular the effect of the thermal resistance of the thermopile black on the apparent reflectivity and on the thermopile sensitivity. A.

536.531 : 536.48

7639. Examination of the resistance of carbon for the measurement of very low temperatures. A. Lacaze and J. Peretti. Letter in *J. Phys. Radium*, **14**, 350–1 (*May*, 1953) *In French.*

It is shown that the resistance of a thin layer of pure graphite deposited from a colloidal dispersion in isopropyl alcohol is sufficiently stable to allow of its use as a resistance thermometer. The thermal capacity is low and temperature gradients are virtually eliminated as the deposit can be made on non-conducting specimens. Some results are shown graphically in comparison with other methods and a sensitivity of 0·001° is claimed for a nominal resistance of 3132 Ω. E. H. DOCK

536.63

7640. A surface contribution to the Debye specific heat. R. STRATTON. *Phil. Mag.*, **44**, 519–32 (*May*, 1953).

The vibrations of a bounded lattice are identified with those of an elastic medium (isotropic, arbitrary elastic constants) having stress-free surfaces. The densities of the representative points in wave number space for the four possible types of vibration are estimated. These estimates are carried one step farther than the usual (Debye) method by including terms proportional to the surface. Summing over the densities, the total number of excited modes and the intrinsic energy of the lattice vibrations are obtained in the usual manner. From these we calculate surface terms for the Debye temperature and specific heat and for the free energy of the lattice vibrations. A.

536.63

7641. $C_p - C_v$ in silicon and germanium. M. E. FINE. Letter in *J. chem. Phys.*, **21**, 1427 (*Aug.*, 1953).

Graphs the values of $C_p - C_v$ for Si and Ge, evaluated from the thermodynamic relation $C_p - C_v = 9\alpha^2 VT/K_T$, where α is the coefficient of linear expansion, K_T the isothermal compressibility, and V the atomic volume; the values obtained are considerably smaller than those estimated from the Nernst–Lindemann equation. F. LACHMAN

536.633.3 : 534.22

7642. Ultrasonic velocities and ratio γ of the specific heats of argon and of nitrogen under pressure. A. LACAM AND J. NOURY. *C.R. Acad. Sci.* [*Paris*] **236**, 2039–41 (*May* 27, 1953) *In French.*

γ is calculated for pressures between 10 and 110 amagats at 25°c from ultrasonics at 584 kc/s. The values agree with those in Abstr. 4773 (1953). C. TURNER

536.633.3 : 534.22

7643. On the ratio γ of the specific heats of nitrogen under pressure. A. LACAM. Letter in *J. Phys. Radium*, **14**, 427 (*June*, 1953) *In French.*

The ratio of the specific heats of nitrogen is obtained from measurements of ultrasonic velocity as a function of pressure at 25°c. The values show good agreement with those of Michels from compressibility measurements up to about 450 atm, but for higher pressures there is an increasing divergence. It is suggested that this may be due to dispersion at high pressures. F. E. HOARE

536.655

7644. Molecular species evaporating from a carbon surface. W. A. CHUPKA AND M. G. INGHRAM. Letter in *J. chem. Phys.*, **21**, 1313 (*July*, 1953).

Continuation of earlier work [Abstr. 3275 (1953)] with improved accuracy. The presence of a C_3 molecule was confirmed in the carbon vapour, and its heat of sublimation estimated. J. HUGHES

THERMODYNAMICS 536.7/.8

536.7

7645. On the thermodynamics of irreversible processes. R. GIBERT. *C.R. Acad. Sci.* [*Paris*] **236**, 2145–7 (*June* 1, 1953) *In French.*

Onsager's relations, obtained from statistical mechanics, have been supposed generally to be unobtainable from classical thermodynamics. The author shows, however, that the relations may be obtained directly from the Clausius equation for entropy increment in a system. F. E. HOARE

536.7 : 530.162

The effect of the [type of] statistics upon Maxwell's demon. *See Abstr.* 7472

536.71

7646. Deviations from the principle of corresponding states. D. COOK AND J. S. ROWLINSON. *Proc. Roy. Soc. A*, **219**, 405–18 (*Sept.* 22, 1953).

Certain intermolecular potential energies which are functions of the relative orientation of the molecules may be reduced to a form similar to that of simple spherical molecules by taking a statistical average over all orientations. Such an average energy is an explicit function of the temperature. Two such intermolecular potentials are used to calculate the difference in the equations of state of assemblies of elliptical molecules, of dipolar molecules, and an assembly of equivalent spherical molecules, which conforms to the principle of corresponding states. These calculations are compared with the observed deviations from this principle of the vapour pressure and rectilinear diameter of thirteen liquids. A.

ELECTRICITY 537

THEORY . ELECTRONS 537.1

537.12

7647. The new classical electrodynamics. M. A. MELVIN. Letter in *Nature* [*London*] **171**, 890–2 (*May* 16, 1953).

Dirac's new field equations are interpreted in terms of fine-grained streams of charged particles all with the same constant mass and charge, and the equations are written in a form analogous to those of London's theory of superconductivity. Physical consequences of the differentiability of the 4-velocity field and of the gauge-fixing condition are discussed. R. A. NEWING

537.12

7648. On the interpretation and generalization of Dirac's theory of the electron. W. WESSEL AND S. J. CZYZAK. *Phys. Rev.*, **91**, 986–94 (*Aug.* 15, 1953).

The independence of momentum and velocity in Dirac's theory of the electron may be understood classically as a consequence of the radiation reaction force. In earlier work one of the authors has tried to interpret the whole spin phenomenon on this basis, considering the new degrees of freedom as representatives of the higher time derivatives in the equation of motion of a particle extended in space. A consequent treatment of this question by Bopp on the basis of his linear electrodynamics revealed that this programme is possible only for integral spin; also, it seemed to be necessary to ignore the non-conservative part of the radiation reaction force. It is shown here that without alteration of the new formalism the spin may be introduced as an intrinsic feature of the particles, as in older theories, so that half-integral

values are included. The Poisson brackets are derived in full generality without reference to a specific model by extension of an idea of Anderson. It is then shown by a contact transformation first discovered in quantum mechanics that the motion under the (third order) radiation reaction force is contained as a particular integral in the (fourth order) equations of motion, which the authors have in common with Bopp. This holds exactly in absence of the Lorentz force and suggests a simple scheme for the interpretation in quantum mechanics of the radiation reaction. In order to maintain nearly the particular motion in presence of the Lorentz force, a slight alteration of the Hamiltonian is necessary, which has empirical support from the evaluation of the corresponding wave equation. A.

ELECTROSTATICS . DIELECTRICS 537.2

537.22 : 539.169

7649. The use of Tl^{204} in radioactive static eliminators. J. F. CAMERON. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. I/R*1216, 6 *pp.* (1953).

Measurements of the discharge current of a standard 30 mC Tl^{204} static eliminator operating with a charged metal plate are described. The probable performance of such an eliminator in discharging sheets of insulating material is deduced. A.

537.221 : 621.317.32

7650. A simple varying capacitor method for the measurement of contact potential difference in high vacuum. H. P. MYERS. *Proc. Phys. Soc.* [*London*] *B*, **66**, 493–9 (*June*, 1953).

Methods of measuring work function are discussed. An apparatus based upon Kelvin's original method for the measurement of contact potential difference and suitable for use in vacua of 10^{-8} mm Hg is described. The value of contact potential difference between copper and silver films evaporated on to tungsten sheets was found to be $0{\cdot}28 \pm 0{\cdot}03$ V, the silver being positive with respect to copper. A.

537.226

7651. Dielectric relaxation time of polar molecules in solution. N. E. HILL. Letter in *Nature* [*London*] **171**, 836–7 (*May* 9, 1953).

A relationship $\tau = (A\eta_{AB})/2kT$ is proposed in which A is a molecular size factor and η_{AB} the "mutual viscosity" of the solvent and solute. Agreement with experiment is discussed. D. H. WHIFFEN

537.226.2

7652. Dielectric dispersion of water vapor adsorbed on silica gel. K-I. KAMIYOSHI AND T. ODAKE. Letter in *J. chem. Phys.*, **21**, 1295–6 (*July*, 1953).

The low-frequency dielectric dispersion was observed at various temperatures T and adsorbed quantities, and a linear relation between log resonant frequency f and amount adsorbed was found; also a further linear relation between $\log f$ and $1/T$. The dispersion seems to arise from phenomena of the type described by Wagner. C. A. HOGARTH

537.226

7653. The rectifying property of polarized barium titanate. D. L. WAIDELICH. Letter in *J. Acous. Soc. Amer.*, **25**, 796 (*July*, 1953).

If a small wafer of $BaTiO_3$ is polarized in a high d.c. electric field for some time, removed from the field and then a high a.c. applied, a small d.c. is observed and is considered to be due to asymmetrical charging during the initial polarization. C. A. HOGARTH

537.226.

7654. Double hysteresis loop of $BaTiO_3$ at the Curie point. W. J. MERZ. *Phys. Rev.*, **91**, 513–11 (*Aug.* 1, 1953).

It is known that the Curie point θ of the ferroelectric $BaTiO_3$ shifts to higher temperatures when a d.c. bias field is applied. If the crystal shows a sharp transition, we expect by applying an a.c. field at the Curie temperature that the crystal would become alternately ferroelectric and nonferroelectric in the cycle of the a.c. field. This can be seen in the shape of the hysteresis loop at temperatures slightly above θ. In the centre of the polarization P *v.* field E plot, a linear behaviour is observed, corresponding to the paraelectric state of $BaTiO_3$ above θ. At both high voltage ends, however, a hysteresis loop corresponding to the ferroelectric state is observed. A change in temperature causes a change in size and shape of the double hysteresis loops, ranging from a line with curves at the ends (higher temperature) to two overlapping loops (lower temperature). The results obtained allow the different constants in the free-energy expression of Devonshire and Slater to be calculated. One of the results shows that the transition is of the first order since the P^4 term turns out to be negative. The properties of the hysteresis loops are discussed, especially the large spontaneous electrical polarization and the low coercive field strength. A.

537.226.2 : 532.7 : 539.13

7655. Dielectric constant theory for polar liquids. W. F. BROWN, JR. *J. chem. Phys.*, **21**, 1327–32 (*Aug.*, 1953).

In Debye's theory of polar fluids, the electrostatic interaction of the molecules was taken into account by introducing the Lorentz local field formula. This formula is inaccurate, especially for liquids. More recent treatments are of two types. One, developed by Onsager, treats one molecule explicitly and replaces the others with a continuum. The other, developed by Kirkwood, uses the statistical mechanical theory of strongly interacting molecules. The second method is rigorous and can be used to derive the approximate results of the first; nevertheless, the first has remained popular because of its simplicity. The treatment presented here attempts to combine the rigour of Kirkwood's method with the simplicity of Onsager's. This is done by use of several useful theorems of classical electrostatics, which are overlooked when dielectrics are treated in the traditional textbook manner. The result is shown to be equivalent to Kirkwood's; but it is in a more flexible form, and it can, therefore, be used to derive approximations of a more general class. A.

537.226.2 : 536.424

7656. Phase transitions in antiferroelectric $PbHfO_3$. G. Shirane and R. Pepinsky. *Phys. Rev.*, **91**, 812–15 (*Aug.* 15, 1953).

Phase transitions in ceramic $PbHfO_3$ have been studied by dielectric and structural measurements. The dielectric constant is about 90 at room temperature, and its temperature dependence shows a small anomaly at 163°c and a pronounced peak of 540 at 215°c. The *P–E* relation, however, is almost linear, showing no ferroelectric hysteresis loops within this temperature range. At room temperature $PbHfO_3$ has a tetragonal lattice of the perovskite type with $a = 4{\cdot}136$ Å and $c/a = 0{\cdot}991$, and a powder X-ray photograph shows some superstructure lines which have essentially the same character as those of $PbZrO_3$. This shows that $PbHfO_3$ is an antiferroelectric of the $PbZrO_3$ type below 163°c. The crystal structure between 163°c and 215°c is also based on a tetragonal lattice; but the axial ratio c/a is much closer to unity (0·997), and the observed superstructure lines are different from those of the lowest phase. Thus the intermediate phase is another antiferroelectric phase, with a different type of dipole arrangement from that of the lowest phase. At 215°c, it becomes paraelectric, accompanied by a change to a cubic structure. A.

537.226.2 : 536.48

7657. Study of the dielectric behaviour of cyclohexanol at low temperatures. L. Reinisch. *C.R. Acad. Sci.* [*Paris*] **237**, 50–2 (*July* 6, 1953) *In French.*

Four experiments (rapid or slow cooling to temperatures of −190°c or −85°c, followed in some cases by slow heating) with cyclohexanol of $n_D^{22} = 1{\cdot}463217$ and a melting-point of +23 ±0·5°c have resulted in a satisfactory agreement with the results of Kelley (1929), the only major difference being the temperature of transformation of −96°c compared with Kelley's −113°c. F. LACHMAN

537.226.2 : 537.57

7658. Dielectric polarization and self-ionization in carboxylic acids. F. E. Harris and B. J. Alder. Letter in *J. chem. Phys.*, **21**, 1306–7 (*July*, 1953).

The large values obtained experimentally for the dielectric constants of some carboxylic acids and their increase with increasing temperature can be explained by a self ionization process within the dimer units, in which proton is transferred from one monomer molecule to the other. It is possible under certain assumptions to calculate the number of ion pairs per unit volume so formed from the experimental dielectric constants, and hence the equilibrium constants and thermodynamic functions for the ionization process. The effect is, however, found to be unimportant in the case of water. H. H. GREENWOOD

537.226.2 : 621.3.011.5 : 621.315.61

7659. The dielectric properties of certain benzene derivatives in the solid state. A. Turney. *Proc. Instn Elect. Engrs IIA*, **100**, *No.* 3, 46–53, *Disc.* 54–60 (1953). For abstract, see Abstr. 210 (1953).

537.226.2 : 621.3.011.5 : 621.317.335.3 : 621.315.61

7660. Dielectric constant measurements at 8·6-mm wavelength. P. Hertel, Jr, A. W. Straiton and C. W. Tolbert. Letter in *J. appl. Phys.*, **24**, 956–7 (*July*, 1953).

Values for various aqueous specimens, ethyl alcohol, saturated solution of NaCl, and dry soil are reported. The values for water and ethyl alcohol agree well with the theoretical calculations of Saxton and Lane [Abstr. 833 (1953)]. C. A. HOGARTH (R)

537.226.2 : 621.315.59 : 621.3.011.5 : 621.318.1

7661. Dielectric behaviour of granular semi-conducting aggregates, with special reference to some magnesium ferrites. A. Fairweather and E. J. Frost. *Proc. Instn Elect. Engrs IIA*, **100**, *No.* 3, 15–22, *Disc.* 54–60 (1953).

For abstract, see Abstr. 4080 (1953).

537.226.8

7662. Note on the electric and the diamagnetic susceptibilities of compressed gases. B. R. A. Nijboer. Letter in *Physica*, **19**, 454–6 (*May*, 1953).

Departures from the Clausius–Mosotti form for polarizabilities at high pressures due to changes in individual atoms are related to similar changes in the diamagnetic susceptibility and so may be distinguished experimentally from internal field effects—at least in principle. D. H. WHIFFEN

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 539.11

Some difficulties of the electron theory of metals. *See Abstr.* 7817

537.311.3 : 550.837.3 : 621.317.331 : 621.317.733

7663. High resistance bridge for conductivity measurements. M. Unz. *J. sci. Instrum.*, **30**, 179–84 (*June*, 1953).

A bridge has been developed for those resistance measurements in which no proper power or potential terminals are available. A high-resistance network with an amplifier unit for balance indication has been incorporated in the bridge, to match the intermediate impedances of the outer circuit. The bridge replaces the indirect methods used at present in geophysical prospecting, when the blocking resistances of the ground electrodes may amount to thousands of ohms. Examples of its industrial application are given; its performance when operated on d.c. and low-frequency a.c. is investigated. Sources of error and sensitivity are discussed. A.

537.311.3.08

7664. Electrical conductivity measurements using direct currents. P. L. Kirby. *J. Soc. Glass Technol.*, **37**, 3T–6T (*Feb.*, 1963).

The use of a commutator to prevent electrode polarization during d.c. conductivity measurements on glass is discussed, and the advantages of a high-speed relay system are given. The achievement of efficient commutation and a balanced alternating output wave-form is described. A.

537.311.31 : 536.212.2

The thermal and electrical conductivities of beryllium. *See Abstr.* 7621

537.311.31 : 536.48

7665. A method of determining electrical resistivities at low temperatures. D. C. BAIRD AND W. S. BOYLE. Letter in *J. appl. Phys.*, **24**, 958 (*July*, 1953).

A method is described for measuring the resistivity of copper at liquid helium temperatures by observing the decay time of an induced current pulse in a specimen in the form of a ring. The resistivity is found to be effectively constant (about $1{\cdot}057\times10^{-8}$ ohm-cm) from 1·5° to 4·2°K. M. R. HOPKINS

537.311.31 : 539.11

The influence of short-range order on the electrical resistivity of alloys. *See Abstr.* 7816

537.311.31 : 539.234

7666. Further contribution to the study of the variation of the electrical resistance of very thin metallic deposits as a function of the applied voltage. J. ROMAND, R. AUMONT AND B. VODAR. *C.R. Acad. Sci.* [*Paris*] **237**, 33–5 (*July* 6, 1953) *In French.*

See Abstr. 4797 (1953). More sensitive methods of measurement have shown that in the region of low voltages (down to 1 V) log R is a linear function of V. The interpretation of this is discussed.

E. H. SONDHEIMER

537.311.31 : 539.4.016

7667. Effect of cold work and anneal on resistivity of alpha brass. H. I. FUSFELD. Letter in *J. appl. Phys.*, **24**, 1062–3 (*Aug.*, 1953).

Rods of 70/30 composition, and of high-grade commercial purity, were pulled in tension to give either 1%, 10% or 20% elongation and then annealed for ~1 day at one of several temperatures between 28 and 246°C. Their electrical resistivities R plotted against temperature of anneal T show a maximum and a minimum at $T = 100$ and 180°C respectively; R for any one T is higher the larger the strain, except for the lowest T where it is the same for each strain. Comparison with the results of Masima and Sachs [(1928), reconsidered by Seitz, Abstr. 2246 (1952)] on the density of similar specimens annealed for ½ hr after straining, which show a max. and min. at 200 and 400° respectively, leads to an activation energy for the recovery of ~19 000 cal. The results are attributed to the operation of several simultaneous and competing recovery processes. A. D. LE CLAIRE

537.311.33

7668. On the wavelength dependence of the conductivity produced in CdS crystals by X- and γ-irradiation. G. FROHNMEYER, R. GLOCKER AND D. MESSNER. Note in *Naturwissenschaften*, **40**, *No.* 12, 338 (1953) *In German.*

For crystals approximately 0·5 mm thick, the maximum conductivity change occurs in the region 1 Å for X-rays and about 1 MeV for γ-rays.

C. A. HOGARTH

537.311.33

7669. n-Type surface conductivity on p-type germanium. W. L. BROWN. *Phys. Rev.*, **91**, 518–27 (*Aug.* 1, 1953).

A positive charge on the surface of a p-type germanium crystal induces a net negative space charge within the crystal adjacent to the surface. This space charge is composed of ionized acceptor atoms and also of electrons under certain conditions. When electrons occur they provide a layer of n-type conductivity immediately under the p-type germanium surface. Such a layer has been found on the p-type region of some n-p-n transistors. In the n-p-n structure the layer of electrons appears as an extra conducting path—"a channel"—across the p-type material between the two n-type ends. The conductance of a channel and the capacity between the channel and the p-type material have been measured and compared with the theoretical predictions based on a simple model. A.

537.311.33

7670. Current carrier mobility ratio in semiconductors. L. P. HUNTER. *Phys. Rev.*, **91**, 579–81 (*Aug.* 1, 1953).

The ratio of the electronic mobility to the hole mobility in germanium has been reported by many workers. The ratio reported is usually obtained by measurements on two different samples of different conductivity types. The method suggested here deduces the mobility ratio from resistivity measurements made on a single sample. An accurate plot of resistivity as a function of temperature is made. The extrinsic and intrinsic branches of this curve are extrapolated to their intersection. If r is defined as the ratio of the resistivity of this intersection point to the measured resistivity at the same temperature, the quantity $[1/(r-1)-r]$ gives the mobility ratio for P type samples, and its reciprocal for N type samples. A.

537.311.33 : 538.632

7671. Diffusion currents in the semiconductor Hall effect. R. LANDAUER AND J. SWANSON. *Phys. Rev.*, **91**, 555–61 (*Aug.* 1, 1953).

The usual Hall effect equation for semiconductors applies if the concentration of carriers is undisturbed. In a magnetic field, however, holes and electrons are swept to the same side of the conductor. A gradient of carrier concentrations is thereby established, giving rise to diffusion currents across the sample. The magnitude of the diffusion currents depends on the recombination velocity at the surface and on the lifetime of excess carriers in the interior. Partial differential equations governing the electric field and the variation of the carrier concentrations across the transverse cross-section of the Hall sample are obtained. These are applied to rectangular and circular transverse cross-sections. Equations for the Hall voltage as a function of both bulk lifetime and surface recombination velocity are derived and discussed. The analysis considers only disturbances which are linear in the applied magnetic field. A.

537.311.33 : 621.315.59

7672. D.C. field distribution in a "swept intrinsic" semiconductor configuration. R. C. PRIM. *Bell Syst. tech. J.*, **32**, 665–94 (*May*, 1953).

Contains an analysis of the d.c. field intensity distribution in an idealized one-dimensional n-intrinsic-p semiconductor system biased in reverse (n positive with respect to p). The paper gives some quantitative insight into the progressive penetration of the field into the intrinsic region as the magnitude of the bias voltage is increased, the field sweeping most

of the mobile carriers out of the intrinsic material and producing a region of material supporting a high field and having a high resistivity. W. BARDSLEY (R)

537.311.33

7673. Some thermal properties of point-contact germanium diodes. J. R. TILLMAN AND J. C. HENDERSON. *Phil. Mag.*, **44**, 677–96 (*July*, 1953).

The isothermal inverse voltage/current relationships of several types of point-contact germanium diode have been measured. They extend well beyond the turnover voltage, which is noted when only slowly increasing currents are applied, but are far from linear. With the assumption, whose validity is discussed, that they can be used to measure the temperature of the barrier layer, other thermal behaviour of the diodes can be investigated. Thus the temperature rise of the barrier layer has been found to be approximately proportional to the wattage dissipated over an important range of wattage; on cessation of a constant dissipation the excess of the temperature of the layer, over the ambient, falls rapidly, e.g. to 40% in about 5 μsec. The derived data have been used to test a model of the diode, because both the proportionality and the rate of cooling can be correlated with the radius of the hemispherical shell assumed to constitute the barrier layer, the necessary physical constants of germanium being known. Although qualitative agreement is found, there are quantitative differences which are difficult to account for. The data are also used to predict the shape of the steady state relationship up to and beyond the turnover voltage. Here good agreement is seen, which is taken as confirming the idea that turnover is largely the result of self-heating. A.

537.311.4

7674. Study of the electrical conduction by tunnel effect for an imperfect contact between two identical metals. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **236**, 2486–8 (*June* 29, 1953) *In French.*

An approximate solution is given for calculating the image force in a study of the potential barrier between two metals. The concepts of transmission coefficient and of tunnel effect current are used.

C. A. HOGARTH

537.312 : 536.2

7675. The phenomenological treatment of electrical and thermal conduction and its application to transverse galvanomagnetic and thermomagnetic phenomena. J.-P. JAN. *Helv. phys. Acta*, **26**, *No.* 3–4, 281–90 (1953) *In French.*

A brief review of the classical theory of conduction phenomena in the presence of a magnetic field based on general equations due to Meixner [*Ann. Phys.* [*Leipzig*] **35**, 701 (1939)]. E. P. WOHLFARTH

537.312.5

7676. Action of a stream of electrons on the sensitive layer of valve photocells. B. P. ANGELOV, E. M. LOBANOV AND S. V. STARODUBTSEV. *Dokl. Akad Nauk SSSR*, **85**, *No.* 4, 733–5 (1952) *In Russian.*

When selenium and silver sulphide photo-cells were irradiated with a stream of electrons, 800–20 000 eV, intensity I_n, the current I_e due to the primary electron beam (i.e. the total photocurrent corrected for that produced by scattered light) increased at first linearly with I_n, later becoming parallel to the I_n axis: the initial slope of the plot falls with increasing external resistance. The volt-ampere characteristics are linear at all values of I_n. The e.m.f. E_e and the current I_e of the cell on short circuit reach a saturation value after an initial linear increase with I_n. The electron yields are high (150), and an ionizational mechanism to account for them is discussed.

R. C. MURRAY

537.312.5

7677. Effect of oxygen on the conductivity and the photoconductivity of lead sulphide photoconductors. S. M. RŸVKIN AND L. N. MALAKHOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 765–8 (1952) *In Russian.*

Increase in the amount of reversibly bound oxygen merely increases the lifetime, but not the mobility of the photo-current carriers, and thus affects the photoconductivity merely by creating diffusional, but not main impurity, centres. However, O affects the mobility of the dark current carriers, an unexpected result which can be explained by the reversibly-bound O merely affecting the properties of the interstitial layers between the PbS crystals. Hence it is maintained that the nature of these layers affects not only the electrical but also the photoelectrical properties of PbS. R. C. MURRAY

537.312.5

7678. Pulsed irradiation of differently arranged photocathodes with semiconducting intermediate layers. W. KLUGE AND S. WEBER. *Naturwissenschaften*, **40**, *No.* 11, 315 (1953) *In German.*

Current-voltage characteristics are shown for Ag–Cs_2O–Cs photocells irradiated by 15 μsec pulses from an argon high-pressure discharge. C. A. HOGARTH

537.312.5

7679. Photoemission from silver into AgCl, KBr, NaCl, and new bands of photosensitivity in AgCl. M. A. GILLEO. *Phys. Rev.*, **91**, 534–42 (*Aug.* 1, 1953).

The work required to move an electron from a metal into an insulator has been investigated photoelectrically. The work function thus found was about 4·3 eV for Ag evaporated in vacuum on KBr (Fowler plot) as well as on NaCl (threshold wavelength). The photoelectrons become trapped in these crystals at vacant anion sites and may be released by *F*-band illumination. For Ag on AgCl a work function of 1·1 eV is measured at the low temperatures used to freeze out ionic conductivity. In AgCl seven new bands of photosensitivity were found; the corresponding optical absorption was too small to be measured directly. These bands have a half-width of ~0·2 eV at 90°K and are bleached by irradiation. The 4400, 5000, 5700, 6600 and 7500 Å bands increase in intensity with an increasing supply of electrons provided by photoelectric emission. These bands are identified, by their location and behaviour, with the *F*, *E*, *D*, *C* and *G* bands (Petroff's notation) in the alkali halides. The 4800 Å (*A* band) and 9200 Å bands are favoured by a scarcity of electrons and may correspond to trapped holes. Photosensitivity in all these bands can be created by irradiation in the intrinsic optical-absorption edge of AgCl at low temperature. They may not be characteristic of a perfect crystal. The intrinsic band-like photoconductive response of AgCl and the absorption edge

on which it occurs shift toward shorter wavelengths with decreasing temperature. The maximum of response which appears with decreasing wavelength may arise from a bimolecular recombination of charge carriers released by light. The absorption edge steepens as it shifts toward shorter wavelength with decreasing temperature. A.

537.312.5

7680. The photoemission of tungsten in the region of predicted Schottky deviations. E. E. Buder, J. J. Ruddick and A. H. Weber. *Phys. Rev.*, **91**, 561–6 (*Aug.* 1, 1953).

Experimental evidence for the existence of deviations from the photoelectric Schottky line theoretically predicted by Guth–Mullin has been obtained. In the phase of the periodic deviations an averaging of data yields for example a maximum at 219 ± 18 $(V/cm)^{\frac{1}{2}}$ and a minimum at 278 ± 16, in agreement with theoretical values of 215 and 285, respectively. The amplitudes of the deviations are 0·3–1·5 the predicted values with smaller than theoretical values predominating. A noted difference between data from a.c. and d.c. heated filamentary cathodes is considered in relation to the effect of emission surface roughness on electric field strength calculations. Also, patch theory has been applied to the photoelectric data, supplying evidence of patches of about 6 microns in extent for d.c. heated wires. An electron microscope study of the tungsten filament emission surfaces supports the conclusions. The influence of more recent theory on the interpretation of the experimental results is briefly discussed in an appendix. A.

537.312.5

7681. The photoelectric effect of thin Bi films. D. J. Fourie. *Phys. Rev.*, **91**, 803 (*Aug.* 15, 1953).

Thin Bi films on glass were obtained by sputtering in A. The photoelectric currents were measured when ultraviolet light was focused on a film, and at the same time direct current passed through the film in one direction and also in the reversed direction, as well as alternating current. It was found that only relatively large alternating currents affected the photocurrent—thus heating alone did not affect the photocurrent much. The direction and magnitude of the direct currents, however, affected the photocurrent appreciably. A.

537.312.5 : 548.7

7682. Irradiation-induced photoconductivity in magnesium oxide. H. R. Day. *Phys. Rev.*, **91**, 822–7 (*Aug.* 15, 1953).

Crystals of magnesium oxide have been coloured by irradiation with ultraviolet light and neutrons. The spectral distribution of optical absorption has the form of a gradually increasing tail extending from the visible region to the far u.v. upon which are superimposed several absorption bands. Photoconductivity in single crystals of magnesium oxide was measured by a d.c. method using a vibrating reed electrometer. The spectral distribution of photoconductivity is characterized by a gradually rising tail with superimposed peaks at 2·1, 3·7 and 4·8 eV, corresponding to known optical absorption bands. A photoconductivity band was found at 1·2 eV which has not been detected by optical absorption measurements. Irradiation of the crystals by ultraviolet light causes an enhancement of the photoconductivity subsequently measured in the 1·2 and 2·1 eV bands. The enhancement effect reaches a saturation level which is independent of the intensity of the u.v. light and which is a measure of the density of imperfections in the crystal lattice. The u.v. activated region can be displaced by an electric field in such a direction as to indicate that the charge carriers are holes in the valence band. Neutron irradiation of the crystals gives rise to a thermally unstable enhancement of photoconductivity throughout the spectrum and also causes an increase in the level of saturation of the u.v. activation. The latter increase is stable at room temperature and indicates that the neutron irradiation produces new lattice defects. This effect saturates with increasing neutron flux. An estimate of the density of lattice defects can be made from the photoconductivity. An energy-level model is proposed to explain the various photoconductivity bands and the enhancement and saturation effects. A.

537.312.5 : 621.383.5

7683. Photomultipliers: a survey of current types. W. E. Turk. *Photoelect. Spectrom. Group Bull.* [*Cambridge*] *No.* 5, 100–9 (*Oct.*, 1952).

Outlines the characteristics of an ideal tube and compares commercial tubes, tabulating essential data. Practical comments on their use are given.

537.312.62

7684. Properties of superconducting indium and thallium films. N. V. Zavaritskiĭ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 749–52 (1952) *In Russian.*

Variation of critical field, h, of these films (deposited at 300°K or at 2°K and annealed at 300°K) with thickness, d ($1{\cdot}7\times10^{-4}$ to $3{\cdot}6\times10^{-6}$ cm), and temperature was similar to that found earlier for tin [Abstr. 1018 (1952)], and the transition temperatures were very close to those of the bulk metals. The penetration depth λ was deduced from the relation $h/Hc = 2\sqrt{6}\lambda/d$ applied to the thinnest films and for indium agreed with Lock's value [Abstr. 7909 (1951)]; the temperature variation agreed with that given by Daunt, Miller, Pippard and Shoenberg [Abstr. 3996 (1949)]. For the thicker films the relation $h/Hc = 1 + k\lambda/d$ was found with $k = 2{\cdot}2 \pm 0{\cdot}5$ for Tl, $1{\cdot}5 \pm 0{\cdot}1$ for In (cf. $1{\cdot}5 \pm 0{\cdot}3$ for Sn) rather than $k = 1$ as predicted by the Landau–Ginsburg theory. D. Shoenberg

537.312.62

7685. Measurements on superconductivity in thin tin films. A. van Itterbeek, L. de Greve, L. van Gerven and J. Schepers. Letter in *Nature* [*London*] **171**, 834–5 (*May* 9, 1953).

Changes in superconductivity are measured under the influence of a magnetic field and also under the combined action of a current and a magnetic field [see Abstr. 8871 (1952)]. Transition curves are shown (R/R_0 against H) for various currents with $H \parallel$ and $\perp$ to the film, but always $\perp$ to the current, at $T = 3{\cdot}60$°K. These curves become sharper with increasing current and the critical field in the $\parallel$ direction is much larger than for the $\perp$ direction.

R. H. Davies

537.312.62

7686. Superconducting compounds. B. T. MATTHIAS. *Phys. Rev.*, **91**, 413 (*July* 15, 1953).

Rh_3Ge_2, $\alpha PdBi_2$, and PdBi become superconducting, respectively, at 2·12°, 3·42° and 3·74°K. See also Abstr. 8213 (1952). H. LONDON

537.312.62 : 536.21

7687. A calculation of the thermal conductivity of superconductors in the intermediate state. F. H. J. CORNISH AND J. L. OLSEN. *Helv. phys. Acta*, **26**, *No.* 3–4, 369–76 (1953).

The effect on the intermediate state thermal conductivity of a superconductor of varying rates of energy transfer between lattice and electrons is examined. The variation of thermal conductivity with magnetic field is calculated and shows fair agreement with experimental data. A.

537.312.62 : 536.21

7688. Heat conductivities of superconductive Sn, In, Tl, Ta, Cb, and Al below 1°K. K. MENDELSSOHN AND C. A. RENTON. *Phil. Mag.*, **44**, 776–81 (*July*, 1953).

The conductivities were determined by the method of Abstr. 1647 (1953). At the lowest temperatures some of the specimens show a proportionality of the heat conductivity with T^3 and it has been suggested that this is heat transport by the crystal lattice only. The bearing of these results on the superconductive heat switch is discussed. A.

537.312.8

7689. The measurement of electrical resistance of the alloy Fe_3Pt in a longitudinal magnetic field. R. G. ANNAEV, V. G. DUBROVSKIĬ AND E. K. KAPUSTYAN. *Dokl. Akad. Nauk SSSR*, **82**, *No.* 4, 549–52 (1952) *In Russian.*

The longitudinal galvomagnetic effect was investigated and the effect varies as the square of the intensity of magnetization in accord with theory [N. S. Akulov, *Ferromagnetism* (1939)]. The magnetization curve and the variation of the galvomagnetic effect with magnetic field intensity and intensity of magnetization for specimens which were annealed and quenched from different temperatures are shown graphically, as is also the dependence on the annealing temperature of the intensity of magnetic saturation, the resistivity and the galvomagnetic effect. W. BARDSLEY

537.32 : 536.48 : 539.11

7690. Thermo-electricity at low temperatures. I. The "ideal" metals: sodium, potassium, copper. D. K. C. MACDONALD AND W. B. PEARSON. *Proc. Roy. Soc. A*, **219**, 373–87 (*Sept.* 22, 1953).

Following a short discussion of the present situation in the electron theory of metals with particular reference to thermoelectricity, experimental data on thermoelectricity at low temperatures is presented and discussed. The three elements—sodium, potassium and copper—have been chosen first as being frequently considered to be "quasi-ideal" metals. The influence of impurities has also been studied particularly in potassium-rubidium and dilute copper-tin alloys. It appears that the theory at present leaves much to be desired, but in any case considerable information on the fundamentals of electron scattering in metals can be obtained from these experimental studies. A.

537.32 : 537.31

7691. Electrical properties of liquid selenium. I. H. W. HENKELS AND J. MACZUK. *J. appl. Phys.*, **24**, 1056–60 (*Aug.*, 1953).

The thermoelectric power of liquid selenium has been measured in the range 250–500°C. Values of activation energies calculated from the temperature dependences of thermoelectric powers and resistivities agree. This activation energy taken as the intrinsic activation energy (or the energy to break the Se–Se bond) is 2·31 eV calculated from data [Abstr. 7246 (1950)]. The mobility of holes in the intrinsic region exceeds that of electrons and has a value $(8{\cdot}4\times10^6)/T^{\frac{3}{2}}$ cm²/volt sec, assuming electronic mass. As a further check of the electronic nature of the conduction in the liquid and of theories of conduction in the hexagonal form, preliminary measurements of the thermoelectric power of pure selenium doped with small percentages of As, Sb and Bi up to 4% were made. In the intrinsic region the specimens exhibited *p* type conduction, but at lower temperatures the sign of the thermoelectric powers reversed and values became quite large but negative. The cross-over point depended qualitatively on the amount of impurity in the correct manner. The *n*-type conduction is tentatively attributed to donor levels introduced by the normal trivalence of Group V_b elements. Two *p* electrons are considered bound in the selenium chain, the third ionized at high temperature. A.

537.323 : 537.311.33

7692. On the theory of the differential thermoelectric power of semiconductors. G. LAUTZ. *Z. Naturforsch.*, **8a**, 361–71 (*June*, 1953) *In German.*

Theoretical derivations of formulae for the thermoelectric power of semiconductors using the classical model and various approximations for the Fermi energy, are compared with certain experimental results for Se, CdSb, and Fe_2O_3 with substituted Ti. C. A. HOGARTH

ELECTRIC DISCHARGES 537.52

537.52

7693. Measurement of the energy of electrons and of positive ions in a gas discharge. N. I. IONOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 753–5 (1952) *In Russian.*

A new type of probe is described, comprising four Pt foil electrodes of which the first is sealed across an opening in the side of the discharge tube, and the others are held parallel behind it, the second being in electrical contact with the first, and forming with the other two a 3-electrode plane parallel condenser, contained in a side tube sealed to the discharge tube and immersed in liquid N. The first three electrodes contain fine slits. This arrangement permitted, by suitable adjustments of the potentials on the various plates, a separation of the positive from the negative ions in the discharge; and from the slope of the plot of the relative ion current reaching the back electrode against the p.d. between that and the front electrode, a determination of the "ion temperature" which was found to be (uncorrected) 1500°K. The electron temperature, deduced in a similar way, agreed with

the usual value deduced from the characteristic of a single probe. R. C. MURRAY

537.523

7694. Formative time lags of uniform field breakdown in argon. G. A. KACHICKAS AND L. H. FISHER. *Phys. Rev.*, **91**, 775–9 (*Aug.* 15, 1953).

The nature of the uniform field breakdown in argon has been investigated by measuring the formative time lags of breakdown as a function of overvoltage (from about 5 to 100%), pressure (150 to 700 mm Hg) and electrode separation (0·3 to 3·0 cm). Formative time lags in argon at a given per cent overvoltage are very long compared to the values previously obtained in air and nitrogen. For most values of pressure and electrode separation studied in argon, an overvoltage of 100% must be applied before the time lags decrease to the order of 1 μsec. The results in argon (like those in air and nitrogen) indicate a Townsend build-up before breakdown. For the range of variables studied in argon, the data cannot be accounted for satisfactorily by build-up as a result of metastable action at the cathode, positive ion bombardment of the cathode, or photoelectric emission from the cathode by photons crossing the gap with a velocity close to c. There is a possibility that the results may be explained by a photoelectric effect at the cathode if delays are introduced due to the diffusion of resonance radiation; this conjecture remains to be verified. At this time the positive identification of the effective secondary mechanism in the breakdown of argon cannot be made. The present results indicate the universality of the Townsend build-up before breakdown, but the build-up may proceed by different mechanisms in different gases. A.

537.523.3

7695. Negative point-to-plane corona; an exercise in the principle of similarity applied to gaseous discharges. A. GREENWOOD. *Proc. Leeds Phil. Lit. Soc.*, **6**, 114–18 (*Dec.*, 1952).

Results are given of measurements on the frequency of current pulses in three similar gaps to which d.c. voltages in the range 6–12 kV were applied. The values of the pulse-frequency/pressure and the mean current for a given applied voltage were found to be approximately the same for all gaps. An explanation is given in terms of the time taken to sweep the ionization-inhibiting space-charge formed by the pulse away from the region of the point. J. DUTTON

537.523.4/5 : 621.319.5 : 535.892 : 535.33.072

A low-voltage spark generator for spectrographic analysis. *See Abstr.* 7556

537.523.5

7696. Determination of the coefficients of cathode disintegration of metals by ions of the same metals. L. N. DOBRETSOV AND N. M. KARNAUKHOVA. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 754–8 (1952) *In Russian.*

The coeffs. for pure Cu, Mn, Fe, Pb and Sn were calculated from measurements of the amount of material removed from the target, p, using the formula $N = 2{\cdot}28 \times 10^6 (p/q)_m/\mu$, where q = quantity of electricity in coulombs incident, in the form of ions of the same metal (from an arc with a heated cathode), on the target during the time that p g of metal is removed; μ = atomic weight of the metal. These give a linear plot against $\sqrt{}$(energy of bombarding ions), similar to that found by other authors, and not in agreement with the thermal theory of cathode disintegration, which predicts a dependence of N on $\mu^{4/3}$ or even on μ. R. C. MURRAY

537.525 : 621.3.015.5

7697. Electrical breakdown in vacuum. D. LEADER. *Proc. Instn Elect. Engrs IIA*, **100**, *No.* 3, 138–40, *Disc.* 175–89 (1953).

For abstract, see Abstr. 249 (1953).

537.525.3

7698. Langmuir adsorption as a determinant of conductivity in a low-frequency electric discharge. A. P. SAXENA, M. G. BHATAWDEKAR AND N. A. RAMAIAH. Letter in *Nature* [*London*] **171**, 929–30 (*May* 23, 1953).

Briefly discusses certain effects in ozonizer tube discharges in terms of adsorption processes. J. D. CRAGGS

537.525.3 : 535.525.72/.8

7699. Limitations of surface layer theories of Joshi effect—a review. A. P. SAXENA AND N. A. RAMAIAH. *J. sci. industr. Res.*, **12A**, 130–5 (*March*, 1953).

Gives a review, with 46 references, of some of the recent work on the effects of external illumination (with visible or near u.v. light) of electrodeless corona discharges at low pressure (ozonizer discharges). J. D. CRAGGS

537.525.3 : 537.525.72 : 537.525.8

7700. Time lag in Joshi-effect. M. B. DESHMUKH. *J. Univ. Bombay*, **21**, 1–4 (*March*, 1953).

Describes a stroboscopic arrangement for observing time lags between irradiation of an electrodeless low pressure corona discharge and the onset of the Joshi effect (alteration of discharge current). The persistence of the Joshi effect after the illumination ceased could also be measured. In both cases the upper limit was about 1 millisec. J. D. CRAGGS

537.525.3 : 537.525.72/.8

7701. An analogue of Joshi effect with thermo-electrons. O. P. DOGRA AND N. A. RAMAIAH. Letter in *J. sci. industr. Res.*, **12B**, 29–30 (*Jan.*, 1953).

Describes certain effects in electrodeless low pressure discharges in iodine vapour, when thermo-electrons from a hot central wire in the tube are emitted into the discharge space. J. D. CRAGGS

537.525.3 : 537.525.72/.8

7702. A note on secondary processes in a low-frequency electrodeless discharge. O. P. DOGRA, M. G. BHATAWDEKAR AND N. A. RAMAIAH. Letter in *Proc. Phys. Soc.* [*London*] *B*, **66**, 431–2 (*May*, 1953).

A brief discussion of secondary mechanisms (Townsend γ processes, etc.) in electrodeless a.c. corona discharges in iodine vapour (ozonizer discharges). J. D. CRAGGS

537.525.3 : 621.316.722.9 : 621.387

7703. Variations in the characteristics of some corona-stabilizer tubes. F. A. BENSON AND J. P. SMITH. *J. sci. Instrum.*, **30**, 192–4 (*June*, 1953).

Several 500 V tubes have been studied in detail. Variations of striking voltage and running voltage from tube to tube have been recorded and the effects

of ambient-temperature changes and of excess current on tube characteristics have been noted. The results of this work are presented together with some information on the running-voltage drifts to be expected during the first 1200 hours of life. The properties of tubes run with reversed polarity are also discussed. A.

537.525.4 : 535.338

7704. The light emitted from condensed vacuum sparks at high current densities. H. GREINER. Note in *Naturwissenschaften*, **40**, *No.* 8, 238–9 (1953) *In German.*

The emission spectrum from a vacuum discharge in a 3·5 mm diam. hard glass capillary, using a $\frac{1}{2}$ μF 10–35 kV condenser, is shown for current densities varying from $14{\cdot}7\times10^3$ to $36{\cdot}8\times10^3$ A/cm². Above approx. 22×10^3 A/cm² the spectrum appears to be largely a continuum (6000–3500 Å approx.).

J. D. CRAGGS

537.525.5

7705. Current densities of free-moving cathode spots on mercury. C. G. SMITH. Note in *Brit. J. appl. Phys.*, **4**, 252 (*Aug.*, 1953).

Describes luminous cathode phenomena in a mercury arc discharge, when subjected to a longitudinal magnetic field, up to $\sim10^4$ gauss in magnitude. The expts. suggest that in certain conditions the current is carried, at the cathode, in extensive areas although the effect of varying the magnetic field is complicated. J. D. CRAGGS

X-RAYS 537.531

537.531

7706. Semi-direct determination of the fluorescence yield of the *K* level of certain atoms from measurements of X-ray line breadths. W. LASKAR. *C.R. Acad. Sci.* [*Paris*] **236**, 2149–50 (*June* 1, 1953) *In French.*

A theoretical value for the Auger transition probability is assumed. Results agree with theoretical predictions. L. PINCHERLE

537.531 : 535.338

7707. The *K* emission spectrum of aluminium in the conductivity band region. Y. CAUCHOIS. *Acta cryst.*, **6**, 352–6 (*April*, 1953) *In French.*

This was studied with the help of the focusing spectrograph and experimental technique previously described [Abstr. 5824 (1952)] and used for observing the absorption spectrum. The window of the tube was of beryllium or lithium, instead of aluminium as usual. The breadth of the $K\beta$ band was found to be smaller than reported in the literature; the maximum of intensity close to the edge reported by Farineau could not be observed. The shape of the $K\beta$ band is compared with that of the *L* band and discussed on the new hypothesis of bound levels due to the *X* ionization in connection with the distribution of states in the first two Brillouin zones. A.

537.531 : 539.172.13

Production of characteristic X-rays by protons of 1·7 to 3 MeV energy. *See Abstr.* 7920

537.531 : 621.386.1 : 621.316.925.43

7708. An overload device for X-ray sets. R. G. ACKLAND. *J. sci. Instrum.*, **30**, 250–1 (*July*, 1953).

The anode current ratings of many industrial and therapeutic X-ray tubes are constant up to a certain kilovoltage and then decrease as the kilovoltage rises. An overload device for inclusion in the control equipment used with such tubes is described; it ensures reasonable compliance of the overload setting with the current rating of the tube, irrespective of the kilovoltage setting. A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

7709. Investigation of electron emission on stripping high polymer films from glass in a vacuum. V. V. KARASEV, N. A. KROTOVA AND B. V. DERYAGIN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 5, 777–80 (1953) *In Russian.*

Observations on luminescence occurring when stripping high polymer (benzyl cellulose and acetyl cellulose) films from glass in vacuum of 10^{-4}–10^{-5} mm Hg. By magnetic deflection and absorption in thin mica films it was shown that effect is due to electrons with energy 10^3–10^4 eV emitted during rapid separation of electric double layer between film and glass. Work of adhesion consistent with electrostatic theory of adhesion is estimated. J. W. MENTER

537.533

7710. Energy distribution of thermal electrons from electron beam producers. H. BOERSCH. Note in *Naturwissenschaften*, **40**, *No.* 9, 267–8 (1953) *In German.*

The obvious assumption that electron beams in electron microscopes exhibit a Maxwellian energy distribution characteristic of the cathode temperature is shown to be false by a retarding-field method capable of resolving energy differences of 0·02 eV at 30 keV. At low cathode temperatures an image of the cathode was obtained and the distribution was normal. At the operating temperature no image could be obtained and the apparent temperature was more than twice T_c. Magnetic focusing of the beam gave further broadening of the distribution. The cause of these effects is twofold, wave amplification in the electron beam, and the effects of space-charge in producing a saddle potential. A. H. W. BECK

537.533

7711. Current density tables for field emission theory. W. W. DOLAN. *Phys. Rev.*, **91**, 510–11 (*Aug.* 1, 1953).

The Fowler–Nordheim field emission equation permits calculation of current density J as a function of surface electric field F and work function ϕ. Computed values of J for $1{\cdot}00\times10^7<F<1{\cdot}00\times10^8$ V/cm and for $2{\cdot}00<\phi<6.30$ eV are tabulated; the table is of use in connection with several theoretical and experimental aspects of field emission. A.

537.533.072 : 621.385.1

7712. A rubber membrane model for tracing electron paths in space charge fields. G. A. ALMA, G. DIEMER AND H. GROENDIJK. *Philips tech. Rev.*, **14**, 336–44 (*May*, 1953).

The motion of electrons in two-dimensional electric fields can be imitated by rolling steel balls over a surface which is a "model" of the potential field.

Such a model can take the form of a uniformly stretched rubber sheet supported in an appropriate manner. It is found that the effect of an electrostatic space charge can be reproduced by applying suitably distributed pressure from beneath the rubber sheet. Since the space charge is caused by the very electrons whose motion it is intended to determine, it is necessary to employ a process of successive approximation. A description of the apparatus for applying the pressure is followed by details of four experiments; the first three of these serve as a check on the method and apparatus used, and hence relate to problems the solutions of which have been obtained by other methods (cylindrically shaped rubber sheet, Pierce electron gun, diode with thermal velocity distribution of the electrons). The fourth experiment concerns the motion of electrons in a microwave valve. Two simple mathematical examples (plane diode, tetrode) demonstrating the speed of convergence of the results obtained by successive approximation are given. A.

537.533.7

7713. Losses of energy of a charge[d particle] in uniform movement. B. Bolotovskiĭ and A. Kolomenskiĭ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 59–61 (1952) *In Russian.*

It is shown that the methods developed by Tamm and Frank (1937) for calculating these losses can yield single-valued expressions for the energy loss (by excitation, ionization and secondary radiation) of a charged particle (electron) moving in a transparent medium, in contradiction to opinions recently expressed by Kunin (1947) and Ivanenko and Sokolov (1949). R. C. MURRAY

537.533.72

7714. On the representation of optical or electron lenses by pure resistance quadripoles. F. Bertein. *C.R. Acad. Sci.* [*Paris*] **236**, 2494–6 (*June* 29, 1953) *In French.*

The similarity between the paraxial ray equation for an electron in an electrostatic field of axial symmetry, and the differential equation describing the potential distribution in a chain of series and parallel connected resistors, suggests a resistor-network method for solving the electron trajectories. A difficulty arises because of dissimilarity in sign between the equations. A method of avoiding this by a transformation of variables is outlined.

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537.533.72 : 621.317.329 : 621.385.833

7715. The potential in an electrostatic electron lens. Comparison of numerical calculations and measurements made in the electrolytic trough. M. Laudet and P. Pilod. *J. Phys. Radium*, **14**, 323–8 (*May*, 1953) *In French.*

Compares the relaxation method with trough plotting. The authors conclude that for a given accuracy, relaxation is quicker and simpler, but the trough plot gives more information. The importance of observing the boundary conditions in trough plotting is emphasized. A. H. W. BECK

537.533.72 : 621.385.833

7716. The practical calculation of third-order aberrations in the centred systems of electron optics. M. Barbier. *Ann. Radioélect.*, **8**, 111–33 (*April*, 1953) *In French.*

The well-known method of trajectory tracing (in which the space is divided into successive intervals for which the potential variation can be approximated by a potential law corresponding with a known trajectory) is extended to the third-order aberrations. It is shown that the expressions for the aberrations can be completely integrated under these conditions and the results obtained agree, for all known cases, with results obtained directly. As an example the aberrations are calculated as a function of lens power for magnetic and e.s. lenses. A. H. W. BECK (R)

537.533.72 : 621.385.833

7717. The effect of pole piece saturation in magnetic electron lenses. G. Liebmann. *Proc. Phys. Soc.* [*London*] *B*, **66**, 448–58 (*June*, 1953).

The imaging properties of magnetic lenses in the absence of iron saturation are now well known, but there has been some doubt up to what flux densities the calculated lens performance would be correct. It is shown here that the effect of iron saturation in the pole-piece tips is equivalent to an apparent increase in lens dimensions, apart from a loss of m.m.f. in the iron, which depends on the design of the magnetic circuit as a whole. Published data for unsaturated magnetic lenses can still be used beyond the onset of pole-piece saturation if these effects are taken into consideration. A practical limit of lens operation is reached for a flux density in the iron near the air gap which would make $\mu \simeq 50$. A.

537.533.72 : 621.385.833

7718. On the resolving power of an immersion electron objective. G. V. Spivak and E. M. Dubinina. *Dokl. Akad. Nauk SSSR.*, **88**, *No.* 4, 673–5 (1953) *In Russian.*

In an emission electron microscope it was found possible to increase the field at the cathode by a factor of about 6, without breakdown occurring, provided that the h.v. supply was applied in pulses of $\gtrsim \sim 2\ \mu$sec duration. The lens potentials were pulsed synchronously and some improvement in resolution was obtained, which is illustrated in photographs. There is a brief discussion of the conditions necessary for improvement of resolution, especially with regard to pulse shape and duration and to screen characteristics. J. C. E. JENNINGS

537.533.72 : 621.385.833

7719. The adaptation of an electron microscope for reflexion and some observations on image formation. M. E. Haine and W. Hirst. *Brit. J. appl. Phys.*, **4**, 239–44 (*Aug.*, 1953).

Designs are described of modified mechanical stage arrangements to allow the type E.M.3 electron microscope to be used for the glancing angle "reflection" technique. The theoretical limit of resolution is discussed. For the experimental conditions used, a resolution of about 400 Å would be expected. The actual resolution obtained agrees with this figure. A.

537.533.72 : 621.385.833 : 621.318.1.042

7720. The magnetic circuit in electron microscope lenses. T. Mulvey. *Proc. Phys. Soc.* [*London*] *B*, **66**, 441–7 (*June*, 1953).

Suitable magnetic circuit design curves are given

r the best lens performance, based upon flux easurements in models. The effect of iron saturation briefly described. A.

537.533.72

7721. Beta-ray spectrometer line shapes with tilted ources. H. W. KRUSE, G. P. MELLOR AND C. M. OWLER. *J. appl. Phys.*, **24**, 1037–9 (*Aug.*, 1953).

Experimental line shapes arising from tilted β-ray pectrometer sources are compared with analytically erived line shapes. Although the increased scattering n the source at higher tilting angles considerably lters the experimental line shape, the sharp leading dges predicted for the larger angles are largely etained. This is true for electron energies at least s low as 400 keV, even for quite dense sources 5 mg/cm^2). An application of the increased resolution esulting from this feature is given. A.

537.533.74

7722. Scattering of high-energy electrons and the ethod of nuclear recoil. R. HOFSTADTER, H. R. FECHTER AND J. A. MCINTYRE. Letter in *Phys. Rev.*, **91**, 422 (*July* 15, 1953).

Curves are given showing that the recoil of the target nucleus separates the elastically scattered electrons from different elements, so that elastic scattering can be studied in compounds or with unseparated isotopes at high energies. The observed angular distribution of elastically scattered 116 MeV electrons from gold does not show diffraction peaks and differs from a point charge distribution in falling off more rapidly with angle. J. HUGHES

537.533.74 : 530.145

Evaluation of integrals in the theory of atomic scattering of electrons. *See Abstr.* 7462

537.533.75

7723. Straggling distributions for electrons in passing through thin foils. F. KALIL AND R. D. BIRKHOFF. *Phys. Rev.*, **91**, 505–9 (*Aug.* 1, 1953).

Straggling distributions for the 624-keV conversion electrons from Cs^{137} are examined with a high-resolution β-spectrometer for foils of Be, Al, Cu, Sn, Ta and Pb. Agreement is found with the Blunck–Leisegang theory for the heavy elements, but the energy loss distributions for light elements are found to be about 1·8 times as wide as expected. A.

537.533.8

7724. Secondary electron emission of crystalline MgO. J. B. JOHNSON AND K. G. MCKAY. *Phys. Rev.*, **91**, 582–7 (*Aug.* 1, 1953).

Secondary emission is measured from single crystals of MgO cleaved along the (100) plane. The maximum ratio of secondary to primary current, δ_{max}, is about 7 at about 1000 volts and room temperature. The cross-overs are at 33 volts and far above 5000 volts. Most probable energy of emission is 1 eV or less. A definite effect of temperature is established, δ decreasing with increasing temperature, in accord with expectations for an insulator. A.

537.533.8

7725. The mechanism of self-sustained electron emission from magnesium oxide. D. DOBISCHEK, H. JACOBS AND J. FREELY. *Phys. Rev.*, **91**, 804–12 (*Aug.* 15, 1953).

Thin films of magnesium oxide, under the influence of an electric field, have been observed to emit extremely large secondary emission currents when bombarded with electrons. This current has been found to be exponentially dependent upon the electric field in the oxide film, and under certain conditions, to persist for many hours after the bombarding current has been cut off. Experiments have shown that the enhanced emission is due to the fact that the surface acquires a positive charge during bombardment, thereby creating an intense field in the thin film. Electrons released in the film by internal ionization are then accelerated by the field and cause further ionization, so that eventually an electron avalanche ensues. It has been found that there are two components of the enhanced electron emission. The first component is a true field-enhanced secondary emission effect similar to that described in previous work. The second component is a self-sustained electron emission. This self-sustained electron emission is produced by the same type of avalanche effect, except that the internal ionization of the dielectric is initiated by electrons produced from within the material rather than by electrons bombarding the material from an external source. A.

537.533.8 : 621.385.15.08

7726. A contribution to the measurement of secondary electron emission. H. GOBRECHT AND F. SPEER. *Z. Phys.*, **135**, *No.* 3, 331–48 (1953) *In German.*

A consideration of the measurement errors shows that it is possible partially to compensate for the geometrical errors by a correct choice of potential ratios. An approximation method for determining the proportion of reflected electrons, without reference to their initial direction or spatial distribution, is given. It is assumed that collector and secondary anode are of the same material. For nickel-chrome at 1 kV, 22% of the secondaries were reflected electrons. A. H. W. BECK

537.533.92

7727. The specific probable ionization of electrons observed with a Wilson cloud chamber. R. H. FROST AND C. E. NIELSEN. *Phys. Rev.*, **91**, 864–70 (*Aug.* 15, 1953).

The specific probable ionization of electrons has been measured for the energy range in which it is a rapidly varying function of velocity by counting the droplets along cloud-chamber tracks. The electron momenta have been determined by the use of a magnetic field perpendicular to the direction of photography, permitting counting along appreciable lengths of the helical tracks of slow electrons. The dependence of the measured specific ionization upon velocity agrees within the experimental uncertainty with that predicted by the Bethe–Bloch theory. The ionization in the vapour has been determined experimentally, permitting the determination of the minimum ionization in the dry gases at standard conditions as $46{\cdot}1 \pm 2{\cdot}2$ ions per cm in air, $6{\cdot}48 \pm 0{\cdot}34$ in hydrogen, $8{\cdot}13 \pm 0{\cdot}51$ in helium, and $53{\cdot}1 \pm 2{\cdot}8$ in argon, where the statistical probable errors are indicated. These values are compared with the average ionization found for cosmic-ray mesons by Hazen and Skolil. The theoretical minimum rates of energy loss divided by these values give values of the average energy loss per ion pair of $31{\cdot}2 \pm 1{\cdot}5$ eV

for air, 37·2 ± 2·0 for hydrogen, 26·0 ± 1·6 for helium and 27·9 ± 1·5 for argon. A.

537.534

7728. The influence of variation of amplitude of the accelerating field on the movement of ions in linear accelerators. M.-Y. BERNARD. *C.R. Acad. Sci.* [*Paris*] **236**, 2226–8 (*June* 8, 1953) *In French.*

It is shown analytically that it is advantageous for the accelerating field in a linear accelerator to increase with distance during the acceleration. A linear increase of field with distance would give a very satisfactory degree of phase and radial focusing, but would give impracticably large fields towards the end of the apparatus. A field initially increasing almost linearly and later becoming constant is recommended. [See also Abstr. 6855 (1953)]. J. H. FREMLIN

537.534 : 621.384.612

7729. Origin of the "strong-focusing" principle. E. D. COURANT, M. S. LIVINGSTON, H. S. SNYDER AND J. P. BLEWETT. Letter in *Phys. Rev.*, **91**, 202 (*July* 1, 1953).

Acknowledgment of a manuscript by N. Christophilos proposing the use of a strong focusing principle antedating the authors' paper [Abstr. 907 (1953)]. J. H. FREMLIN

537.534.74

7730. Double scattering of high-energy protons by hydrogen and carbon. C. L. OXLEY, W. F. CARTWRIGHT, J. ROUVINA, E. BASKIR, D. KLEIN, J. RING AND W. SKILLMAN. *Phys. Rev.*, **91**, 419 (*July* 15, 1953).

240 MeV cyclotron protons scattered at 27° were scattered from a second target and detected with a scintillation counter. Quadruple coincidences were used, with targets of carbon and polyethylene. Results included: $Pc = 49·8 \pm 4\%$, $P_H = 20·6 \pm 2·7\%$, and asymmetry in a double p–p scattering $2e = 8·5 \pm 2·2\%$. The asymmetry, with C as first and H as second target was $20·6 \pm 2·2\%$. Results are compared with theory. F. R. HOLT

537.534.8

7731. Electron ejection from Ta by He^+, He^{++}, and He_2^+. H. D. HAGSTRUM. *Phys. Rev.*, **91**, 543–51 (*Aug.* 1, 1953).

Measurements of total yield (γ_i) and kinetic energy distribution are reported for electrons ejected from tantalum by the ions He^+, He^{++} and He_2^+ in the kinetic energy range 10 to 1000 eV. The evidence presented indicates that the electrons are released by a collision of the second kind of the ion with the metal surface (potential ejection). One internal secondary electron is produced per incident ion. The probability of this electron escaping is reduced by the possibility of internal reflection at the image barrier at the metal surface. γ_i for the slowest ions is observed to be 0·14, 0·52 and 0·10 for He^+, He^{++} and H_2^+, respectively. The data presented must be considered representative of gas-covered tantalum, since no gas was observed to desorb from the target on heating to 1750°K. γ_i was found not to vary with time after cooling the target indicating rapid re-establishment of the equilibrium gas layer on the surface from within the metal. The work function of the covered Ta surface is found to be $\sim 4·9$ eV, some 0·8 eV higher than that of atomically clean Ta. Considerations based on a theory which includes variation of energy levels near the metal surface sho resonance neutralization of He^+ at the covered T surface not to be possible. Thus only the so-calle direct process of potential ejection occurs, with whic conclusion the measured energy limits of ejecte electrons are in agreement.

537.534

7732. Neutralization of ions and ionization of atom near metal surfaces. L. J. VARNERIN, JR. *Phy Rev.*, **91**, 859–63 (*Aug.* 15, 1953).

Conditions are examined for the resonance transfe of an electron between a metal and an ion or an aton in close proximity to the surface. The point of viev is that of Franck–Condon crossings of potentia energy curves of the initial and final states of th system. The effect of ion image forces is found in many cases to cause a significant variation of transi tion probability with distance. As a result, the con ditions for neutralization of a rare-gas ion to a metastable state and its subsequent de-excitation with the ejection of a secondary electron is found to be severely restricted. In particular, the theory o Cobas and Lamb for the ejection of electrons by the incidence of He^+ on a Mo surface are found to be seriously in error. In such cases an Auger type de excitation is believed to be the mechanism for secondary electron emission. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542 : 539.185.08

Boron layer scintillation neutron detectors. *See Abstr.* 7963

537.542 : 621.396.645.018.756 : 621.387

7733. The gas triode as pulse amplifier tube. E. KNOOP. *Z. angew. Phys.*, **5**, *No.* 3, 105–7 (1953) *In German.*

The application described is to instruments such as counters in which the preservation of the input pulse shape is unnecessary. A special circuit which provides for proper extinction of the tube allows the recovery time of helium-filled tubes (EC50) to be reduced to 2 μsec. For pulses longer than 1 μsec a sensitivity of 0·1 V can be reached, while for shorter pulses several volts are required to trigger the tube. Since the gas tube lengthens the pulse it is only suitable in output stages. A. H. W. BECK

537.542

7734. On the application of Wilkinson's theory to Geiger–Müller counters with external cathode. D. BLANC AND H. ZYNGIER. *C.R. Acad. Sci.* [*Paris*] **237**, 38–9 (*July* 6, 1953) *In French.*

A brief report of expts. with a 2 cm diam. counter, with argon–alcohol filling, which confirm the relation between the charge liberated per count and the operating voltage deduced by Wilkinson [Abstr. 1074 (1949)]. J. D. CRAGGS

537.542

7735. External cathode Geiger–Müller counters for strong irradiation, using pure methylal fillings. D. BLANC. Letter in *J. Phys. Radium*, **14**, 271–2 (*April*, 1953) *In French.*

Describes briefly the characteristics of a Maze-type

ounter, giving due consideration to the effect of the nite resistivity of the glass bulb on the maximum isable counting rate. The plateau gave a rise of ensitivity of about 2% per 100 V in a counter of ormal dimensions, 2 cm Hg filling pressure.

J. D. CRAGGS

537.542

7736. On the importance of the polyatomic [filling] constituent in external cathode counters. D. Blanc and J. Uebersfeld. *C.R. Acad. Sci.* [*Paris*] **236,** 2228–30 (*June* 8, 1953) *In French.*

Discusses the possibility of condensed films forming on the cathodes of Geiger counters, and proceeds to show how this occurs in methylal-filled (7 cm Hg pressure) external cathode counters of the Maze type. The effect is demonstrated by temporal variations in plateau characteristics, which are shown graphically. Stability is reached in about 24 hours. J. D. CRAGGS

537.542

7737. On the localization of the discharge in G.M. counters. E. Picard and A. Rogozinski. *J. Phys. Radium.*, **14,** 304–6 (*May*, 1953) *In French.*

Describes a simple circuit for quenching Geiger counter discharges so that the propagation distance, from the point of initiation, is limited. The advantages of such an arrangement are enumerated; they include the reduction of deadtime and the number of spurious discharges. The counter characteristics are shown graphically and references to earlier work are given.

J. D. CRAGGS

537.542

7738. The stomach counter. J. T. Lloyd. *Atomics* [*London*] **4,** 165–6 (*July*, 1953).

A counter tube $\frac{1}{4}$ in. dia. and 2 in. long on a flexible stem, for measurement of P^{32}, is described.

F. T. FARMER

537.542

7739. Investigation of the condition of the hydrogen filled TPA ionisation chambers. N. Holt and M. Bogaardt. *JENER Rep., No.* 4, 9 *pp.* (1951).

Briefly describes tests on two forms of hydrogen-filled (about 16 atm. pressure) ionization chambers, to provide data on relative sensitivities to γ-rays and neutrons. An argon-filled chamber was used as a standard in the γ-ray calibration of the hydrogen-filled chambers. J. D. CRAGGS

537.542

7740. A low-capacity ionization chamber. G. Bertolini and A. Bisi. *Nuovo Cimento*, **9,** 1022–4 (*Oct.*, 1952) *In Italian.*

A grid ionization chamber of low capacity, able to detect particles of 100 keV. The ratio between signal and noise is ~5. A.

537.542

7741. A.C. operation of ion chambers. A. H. Ward. *Nature* [*London*] **171,** 837 (*May* 9, 1953).

10 c/s was used, and a sensitivity equivalent to 10^{-14} amp. d.c. was obtained. The time constant was about 15 sec. Two argon-filled ion chambers were connected as arms of an a.c. bridge; each balance arm was a variable capacity and parallel resistance. F. R. HOLT

537.542

7742. Recorder for radioactive aerosols (Type E.A.R. 101). J. Labeyrie and M. Pellé. *J. Phys. Radium*, **14,** 477–80 (*July–Aug.–Sept.*, 1953) *In French.*

Designed to register all three types of radioactivity in air by filtering the air through a continuously moving strip of filter paper of special design. The activity of the paper is measured with a proportional counter which either records all rays or only the α-particles. The recorder will detect radiation as small as 200 α-particles/min.m^3 of air. J. M. HOUGH

537.542 : 621.318.572

7743. A device for the stabilization of photomultipliers. R. Ascoli. *Nuovo Cimento*, **9,** 615–17 (*July*, 1952) *In Italian.*

An automatic stabilizer for scintillation counters is described: the constancy of emission of a radioactive source is used to eliminate the troubles deriving from the unsteadiness of photomultipliers with time. The device has given good results in experiments on cosmic rays. A.

537.542

7744. Analysis of counter tube measurements. II. H. Pupke. *Arch. tech. Messen, Issue No.* 210 (*Ref.* J076–8) 153–6 (*July*, 1953) *In German.*

For Pt I, see Abstr. 6877 (1953). Further statistics of particle counting are discussed, with reference to coincidence counting, and the effect of background counts, etc. 68 references are given. J. D. CRAGGS

537.542

7745. On the operation of the diffusion cloud chamber. C. Succi and G. Tagliaferri. Note in *Nuovo Cimento*, **9,** 1092–102 (*Nov.*, 1952).

An experimental model of a downward diffusion cloud chamber has been constructed, and the performance of the instrument investigated. Satisfactory ion tracks were easily obtained, the chamber operation lasting over considerable periods of time, when care is taken to maintain the most suitable boundary conditions. The effect of ion load on the depth of the sensitive layer is deduced by tracing plots of supersaturation distribution. Remarks advising a convenient choice of chamber gas and vapour are appended. A.

537.542

7746. A continuously sensitive diffusion [cloud] chamber. A. Voisin. *J. Phys. Radium*, **14,** 459–62 (*July–Aug.–Sept.*, 1953) *In French.*

Gives details, with a drawing, of a continuously sensitive Wilson chamber (20×40×30 cm). Specimen photographs are also given. J. D. CRAGGS

IONIZATION . THERMIONICS 537.56/.58

537.581

7747. Graphs for a rapid calculation of the work function of thermionic emission. C. G. J. Jansen and R. Loosjes. *Philips Res. Rep.*, **8,** 81–90 (*April*, 1953).

In a brief discussion the relation is shown between

ϕ_0 and A, the work function and the emission constant derived from a Richardson plot, and ϕ and A_0, the work function and the emission constant computed under the assumption of $A_0 = 120$ A/cm² degree². Reasons are given for preferring the latter quantities. For the purpose of rapidly computing work functions ϕ, graphs have been made of j_s, the saturation current density, as a function of T_{abs} with ϕ as a parameter. The range of j_s is 10^{-10} to 10^2 A/cm², of T: 300 to 2400°K, of ϕ: 0·60 to 8·00 V. ϕ can be estimated with an accuracy of 0·01 V. A.

537.583 : 539.217

7748. Diffusion of barium in an oxide-coated cathode. R. S. BEVER. *J. appl. Phys.*, **24**, 1008–10 (*Aug.*, 1953).

The diffusion of Ba through activated BaO–SrO cathode coatings was studied as a function of temperature. Most of the radioactive tracer material diffused according to a dependence of $\log_{10}D$ *v.* $1/T$ similar to that obtained by Redington for diffusion of Ba in single crystals of BaO. The activation energy was 4·1 ± 0·6 eV above 1280°K and 0·40 ± 0·07 eV below that temperature. A.

537.583 : 541.11

7749. A theoretical study of the chemistry of the oxide cathode. E. S. RITTNER. *Philips Res. Rep.*, **8**, 184–238 (*June*, 1953).

A comprehensive theoretical analysis based upon thermochemistry and diffusion theory. The treatment is based on the conventional supposition that excess Ba is required to activate the coating, and accordingly a search is made for materials of sufficient reducing power to serve as activators. Metals which fall into this category include: Th, Mg, Be, Hf, Sc, Y, Sm, Nd, Pr, La, Zr, U, Al, Si, C, and possibly Ti and Ce. A detailed analysis of the factors limiting the generation of free Ba reveals that the most favourable reaction mechanism is that in which the reaction speed is limited by the rate of diffusion of activator in the core metal. The free Ba subsequently finds its way into the individual oxide crystals via the processes of Knudsen flow of the vapour and volume diffusion. An important requirement for the latter step is that the coating be constituted of a porous mass containing fine particles. The evaporation loss during life of the excess Ba is discussed. A.

537.583 : 621.315.59 : 621.38

7750. A simpler explanation for the observed shot effect in germanium filaments. A. VAN DER ZIEL. Letter in *J. appl. Phys.*, **24**, 1063 (*Aug.*, 1953).

An explanation based on fluctuations in the number of electrons only, requires that the electrons arise from traps at a depth of 0·23 eV, in disagreement with Hall effect data. If it is assumed that most electrons come from donor centres and that some of the electrons and all of the holes come from hole-electron pair creation, then creation of pairs and recombinations produce a fluctuation in the number of electrons and an equal fluctuation in the number of holes. An expression for the shot noise was derived on this basis and was used with experimental noise data to calculate the resistivity of intrinsic Ge which resulted in 50 Ω cm as compared with the accepted figure 47 Ω cm at 300°K. A. H. W. BECK

537.583 : 621.385.032.2

7751. Some measurements relative to the filament directly heated thoria cathodes. G. MESNARD. *Vi* **8**, 1326–34 (*March*, 1953) *In French.*

Measurements on tungsten filaments cataphoretically coated with thoria show the dependence heating current, resistance and power on differe thermal treatments. The total emissivity of ThO its spectral emissivity and the correlation of thickne with thermionic emission was also studied.

A. H. W. BE

COSMIC RAYS 537.591

537.59

7752. Cosmic-ray intensity and the temperature the upper atmosphere. H. TREFALL. Letter in *Natu* [*London*] **171**, 888–9 (*May* 16, 1953).

In correlating the meson intensity at sea level wi atmospheric temperature and pressure it is pointe out that if the average pressure level at which meso are produced differs from that assumed addition terms have to be taken into account, and that thes terms may account for the discrepancy between th observed and calculated values of the positive tem perature coefficient. H. ELLIO

537.59

7753. Cosmic rays at 60 m.w.e. underground. I. The knock-on electrons and nuclear interaction produced by relativistic μ-mesons. M. L. T. KANNA GARA AND M. ZIVKOVIC. *Phil. Mag.*, **44**, 797–81 (*Aug.*, 1953).

A length of 126·6 m of minimum ionization trac has been examined in Ilford G5 plates, coated, ex posed and processed at 60 m.w.e. underground and a detailed study of knock-on electrons of energy greater than 50 MeV has been made. After makin suitable corrections for scanning efficiency, it i found that the theoretical cross-section, as derive by Bhabha, fits the data well for knock-on energie greater than 100 MeV. The mean free path for th production of these knock-on electrons is (4·5 ± 1) m of emulsion corresponding to a cross-section o $(20 \pm 4) \times 10^{-28}$ cm²/electron. The theoretical cross section for the μ-meson spectrum at 60 m.w.e. i $18{\cdot}4 \times 10^{-28}$ cm²/electron. A typical μ-meson sta has been found. It is shown that the number of smal stars with less than three dark tracks produced by μ-mesons is not very different from the number o larger stars with three or more dark tracks. No evidence for or against the existence of pairs o associated penetrating particles has been obtained. A

537.591

7754. Cosmic rays at 60 m.w.e. underground. II. The hard and soft components. S. J. GOLDSACK AND M. L. T. KANNANGARA. *Phil. Mag.*, **44**, 811–28 (*Aug.*, 1953).

The tracks of the relativistic charged particles, which have been found and examined by the methods described in Pt I, are used to estimate the total vertical intensity and the electron component at 60 m.w.e. The total vertical intensity is found to be

$(5\cdot8 \pm 1)10^{-4}$ particles/cm².sec.steradian. About 5% of the relativistic charged particles with momenta greater than 100 MeV/c are electrons. The possible sources of these electrons are examined and it is found that they consist almost entirely of knock-on electrons and their cascade progeny. Both the absolute rate and the spectrum of the electron pairs which are found on the plates indicate an electron component whose magnitude is rather greater than can be accounted for by known sources. A detailed analysis is also made of 20 tridents and it is shown that they consist of 9 electron and 11 μ-meson tridents. The μ-meson tridents are classified further into the various cases covered by Bhabha's theory. It is again found that rather more electron tridents occur than are expected. The discrepancy may be due to a fluctuation. A.

537.591

7755. Origin of cosmic rays. J. W. DUNGEY. Letter in *Phys. Rev.*, **91**, 766 (*Aug.* 1, 1953).

Briefly discusses some difficulties associated with the acceleration of particles to cosmic-ray energies, by the betatron process, in magnetic fields which vary with time. H. ELLIOT

537.591

7756. The cosmic-ray albedo. S. B. TREIMAN. *Phys. Rev.*, **91**, 957–9 (*Aug.* 15, 1953).

The fraction of splash albedo radiation leaving the earth which goes into (bound) orbits leading back to the earth is discussed in the Stoermer approximation. It is shown that the returning particles arrive at latitudes very close to the latitudes from which they leave the earth. A qualitative argument indicates that the returning radiation should be roughly isotropic. A.

537.591.1

7757. Nature of the penetrating particles in electron-nuclear showers. S. A. AZIMOV, A. G. BIRGER, V. N. POLYNOV AND S. A. SLAVATINSKIĬ. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 2, 287–90 (1952) *In Russian.*

A continuation of previous work [Abstr. 9568 (1951)] with more refined and accurate apparatus, at a height of 3860 m. The average penetrating particles in these showers has a momentum $< 2\times10^9$ eV/c, and consist 30–50% of mesons, and 70–50% of protons, in good agreement with Butler's results [Abstr. 3236 (1950), 2796 (1951)] and those of the Powell group [Abstr. 6622 (1950)].

R. C. MURRAY

537.591.1

7758. Existence of high energy deuterons in cosmic rays. G. A. MARIKYAN. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 2, 305–7 (1952) *In Russian.*

Among 625 positive particles recorded during an investigation with the large magnetic spectrometer previously described [Abstr. 2792 (1952)], 126 had momenta exceeding the max. "ionizational" momenta for protons of the same range. Measurement of their ionizing capacity showed them to contain a large proportion of deuterons: the plot of I.C. against momentum had a max. at 10^9 eV/c, and lay well above the plot of I.C. calculated from the momenta assuming the particles to be protons, from 7·0 to $18\cdot0\times10^8$ eV/c, the limiting momentum recorded.

R. C. MURRAY

537.591.1

7759. On the nucleonic component in the atmosphere. II. E. CLEMENTEL AND F. FERRARI. *Nuovo Cimento*, **9**, 572–9 (*July*, 1952) *In Italian.*

For Pt I, see Abstr. 2804 (1952).

The spectra of proton and neutron components between 400 and 2200 MeV are given for the three atmospheric depths of 1033, 680 and 310 g-cm^{-2}. The contributions due to radiative and non-radiative collision processes are discussed separately. As primary proton spectrum Winckler's has been used. Both the ionization energy loss and the loss suffered in passing through a nucleus are assumed constant. The results obtained are in good agreement with the existing experimental observations on the behaviour of the proton component in air and on the latitude effect. For the proton-neutron ratio, distinction has been made between a function giving the ratio of secondaries only of both the components, and the real ratio, which takes account of the primary proton spectrum residual. The former, not higher than unity, is a very slowly varying function of the depth, the latter coincides practically with the previous one in the low and middle atmosphere and increases rapidly approaching the top of the atmosphere. A.

537.591.1

7760. The zenithal distribution of the medium energy nucleonic component. P. BASSI, C. MANDUCHI AND P. VERONESI. *Nuovo Cimento*, **9**, 722–5 (*Aug.*, 1952) *In Italian.*

Describes an experiment undertaken to measure the zenithal dependence of the middle energy nucleonic component of cosmic rays, using an ionization chamber. Assuming a distribution of the type $\cos^n\theta$, $n = 1\cdot66 \pm 0\cdot33$. A.

537.591.1

7761. A cloud chamber analysis of cosmic rays at 3500 metres. I. The electronic component from nuclear disintegrations in lead. A. LOVATI, A. MURA, G. TAGLIAFERRI AND S. TERRANI. *Nuovo Cimento*, **9**, 946–58 (*Oct.*, 1952).

A multiplate cloud chamber has been operated at mountain altitude, yielding 16 000 photographs of random expansions. This paper is intended to study the production of electronic component in nuclear disintegrations induced in lead by cosmic-ray particles of moderately high energy. Assuming the neutral meson-hypothesis, the ratio of the numbers of neutral to charged π-mesons forming in these disintegrations is found to be $0\cdot42 \pm 40\%$. The probability of production of electron-photon component in nucleon-Pb nucleus collisions is tentatively reported for two energy intervals: the indicative values are about 0·3 and 0·6 times the geometrical cross-section, for incident particle-energies centred, respectively, around 2 and 6 GeV. It is remarked that the results obtained, though rather poor statistically, are believed to be unaffected by instrumental selections. A.

537.591.1

7762. The intensity of the photon component at 70 000 feet altitude. J. E. Hooper. *Phil. Mag.*, **44**, 871–6 (*Aug.*, 1953).

The intensity of high-energy γ-rays traversing photographic emulsions can be determined by measurements on the electron-pairs resulting from the materialization of the quanta. A difficulty in the practical application of the method arises from the failure to observe short or steeply dipping tracks. A method of correcting for unobserved tracks of electron-pairs is discussed, and is used to obtain an estimate of the vertical intensity of the photon component of the cosmic radiation at 54° N and at an altitude of 70 000 ft. It is convenient to express the intensity in terms of the ratio of the number of quanta to the number of high-energy nucleons at the same altitude. A value of $2{\cdot}88 \pm 0{\cdot}26$ for this ratio has been found. The result is in satisfactory agreement with that calculated on the basis of reasonable assumptions about the energy and frequency of production of π^0-mesons in nuclear collisions in the atmosphere. A.

537.591.1

7763. Collision lengths of neutral, penetrating-shower-producing cosmic radiation in light and heavy water. D. Froman, J. Kenney and V. H. Regener. *Phys. Rev.*, **91**, 707–12 (*Aug.* 1, 1953).

The collision length, L_c, of neutral penetrating-shower-producing cosmic radiation incident through a reinforced concrete roof of thickness 25 g/cm^2 at Los Alamos, New Mexico, altitude 2280 m, was measured in light and heavy water. The values obtained were, for H_2O, $L_c = 113 \pm 10$ g/cm^2 and for D_2O, $L_c = 123 \pm 10$ g/cm^2. Equal masses of oxygen per unit area in the H_2O and D_2O absorbers were used for a determination of the difference between the collision cross-sections of the deuteron and of the proton for the incident particles. The value obtained for this difference was $\sigma_D - \sigma_P = 13 \pm 15$ mb. A.

537.591.1

7764. Effects at Godhavn and lower latitudes of changes in energy and composition of solar cosmic rays. V. Sarabhai and R. P. Kane. *Phys. Rev.*, **91**, 688–9 (*Aug.* 1, 1953).

Time series have been derived for changes of the amplitude and the hour of maximum of the diurnal component of the daily variation of the pressure-corrected meson intensity at Godhavn from Carnegie Institution data. While these series show some features which are strikingly similar to those observed at other stations, the variability at Godhavn is much greater than elsewhere. Comparison of the series at Godhavn with the corresponding series for the mean changes observed at Cheltenham and Christchurch permits information to be derived concerning changes in the mean energy of cosmic-ray primaries responsible for the daily variation, and their "stiffness" in the geomagnetic field. On the basis of an interpretation in terms of continuous emission of cosmic rays from the sun, there is evidence for an increase in the mean energy of solar cosmic rays from 1940 to 1944. Reasons are given for believing that during 1944, the solar cosmic rays became richer in α-particles as compared to protons. A.

537.591.1

7765. Bubble chamber tracks of penetrating cosmic ray particles. D. A. Glaser. Letter in *Phys. Rev.*, **91**, 762 (*Aug.* 1, 1953).

Examples are given of photographs of charged cosmic-ray particles observed in a bubble chamber containing superheated ether at a temperature of ~140°c. Details of the apparatus are given and the theory of operation is briefly discussed. H. ELLIOT

537.591.1

7766. The energy spectrum of the electrons in extensive cosmic-ray showers. C. Milone. *Nuovo Cimento*, **9**, 549–71 (*July*, 1952) *In Italian.*

This was studied at sea level by means of G.M. counters, at two distances d ($d = 0$ and $d = 50$ m) from the core of the showers. Showers were successively selected having, near the core, average density $\Delta = 72; 42; 25; 12{\cdot}5; 6{\cdot}25; 3{\cdot}14$ particles/m^2. The results show that the energy spectrum of the electrons in the showers can be expressed by the relation $N = K(E + E_c)^{-\varepsilon}$, where N is the number of the electrons with energy greater than E, E_c is the critical energy in air, and ε is an exponent which depends on Δ and on the distance of the electrons from the core. The experimental values of ε are lower than the ones predicted by the cascade theory; furthermore at $d = 50$ m electrons have been found with energies too high to be explained on the basis of an electronic cascade initiated in the high atmosphere by a single electron. The disagreement can be eliminated if one supposes that in the extensive showers electrons are produced also by a component, say the N component, which is absorbed in air less than the electrons and contributes to the shower development throughout the atmosphere. A.

537.591.15

7767. The detection of particle showers by means of scintillation counters. R. Ascoli. *Nuovo Cimento*, **9**, 610–14 (*July*, 1952) *In Italian.*

It is shown that scintillation counters are particularly suitable, even for showers constituted of few fast particles, and can substitute coincidence devices. Such a possibility is demonstrated by experiments effected on cosmic rays: setting a lead absorber (15 g/cm^2) on a scintillation counter, a great increase in the rate of the higher pulses was observed: this fact is attributed to electron and photon showers, produced in the lead by cosmic-ray soft component. With a water absorber (15 g/cm^2) the increase was much less. A.

537.591.15

7768. Penetrating particles in extensive cosmic-ray showers and the stage of development of the showers. C. Milone. *Nuovo Cimento*, **9**, 637–41 (*Aug.*, 1952) *In Italian.*

The ratio R of penetrating particles has been determined at the sea level as a function of the mean density Δ of the showers. It is found that R decreases slowly as Δ increases. Comparing this result with the results of measurements performed by other authors at 3260 m, it is deduced that the value of R depends on the stage of the development of the showers and increases with it. A.

537.591.15

7769. The probability of electron localization in extensive showers. G. Poiani and C. Villi. *Nuovo Cimento*, **9**, 825–33 (*Sept*,, 1952) *In Italian.*

The radial distribution of electrons in air showers is studied on the basis of the cascade theory of the photoelectronic component worked out by the Padua group. It is found that the probability of localization of a singly scattered electron to be localized in the annular ring (x', dx') (x' in Molière units) is $\mathfrak{D}(x')dx' = 0{\cdot}153(dx'/x'^3)$. This result is compared with the predictions of other theories. A.

537.591.15

7770. Zenithal distribution of extensive shower particles. P. Bassi, A. M. Bianchi, D. Cadorin and C. Manduchi. *Nuovo Cimento*, **9**, 1037–43 (*Nov.*, 1952) *In Italian.*

Counter measurements are given for the zenithal distribution of particles in extensive air showers. Assuming zenithal-angle dependence of the form $\cos^n \theta$ a value of n is found between 3 and 4. The authors investigate its dependence on the height, the shower density and the zenithal angle. A.

537.591.15

7771. New barometric and temperature coefficients for the frequency of small cosmic-ray bursts. J. W. Broxon. *Nuovo Cimento*, **9**, 1054–70 (*Nov.*, 1952).

This is a continuation of an earlier paper [Abstr. 4502 (1951)]. Records for three of the nineteen months of the cosmic-ray observations primarily considered there have been reprocessed without satisfactory improvement of results. The statistical treatment of data for an earlier series of observations during eighteen months in 1938–39 has been completed with very satisfactory results. For a class of cosmic-ray bursts consisting of about 75 to 95 particles in a very heavily shielded high-pressure chamber at an altitude of 5440 ft, the barometric and atmospheric temperature coefficients have been found to be: $-4{\cdot}58\%$/mm Hg and $-2{\cdot}53\%$/°c, based on daily average values; and $-9{\cdot}05\%$/mm Hg and $-2{\cdot}19\%$/°c, based on monthly average values. With regard to coefficients based on daily average values, the ratio of the barometric coefficient of the radiation producing the small bursts to that of the radiation producing the burst-corrected ionization is about 26, while the corresponding ratio of the temperature coefficients is about 45. Discussion is included regarding the nature of the burst-producing radiation characterized by such large barometric and temperature coefficients. A.

537.591.15

7772. Lateral scattering of showers of low energy. G. Poiani and C. Villi. *Nuovo Cimento*, **9**, 1109–15 (*Dec.*, 1952) *In Italian.*

The integral spread, averaged over the longitudinal extension of an air shower, is calculated according to the unidimensional theory of the electrophotonic cascade. The expressions thus derived, which give numerical results in accordance with those of Roberg and Nordheim, describe the lateral spread [Abstr. 2587 (1949)] in the low and medium energy region. In the high-energy region they give the relations stated by Borsellino [Abstr. 430 (1951)]. A.

537.591.5

7773. Azimuthal asymmetry of cosmic rays in the stratosphere at the equator. S. N. Vernov, A. M. Kulikov and A. N. Charakhch'yan. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 3, 525–8 (1952) *In Russian.*

Measurements have been made of the complete spatial distribution of incoming cosmic rays, both in azimuth and zenith, in equatorial latitudes, by recording signals from systems of telescopes, connected to counters, inclined at different angles to the vertical and maintained at 10, 15, 21 and 26 km in sounding balloons anchored to ships. A large E–W azimuthal asymmetry was found, increasing with the zenith angle, whereas the N–S distribution was practically symmetrical. This supports the view that a large part of the primary cosmic rays are +ve, and shows that the deviation of secondary particles from that of the primary ones does not obscure this asymmetry, and so cannot be adduced to explain the much smaller asymmetry found by Johnson and Barry in 1939. R. C. Murray

537.591.5

7774. World-wide changes in the phase of the cosmic-ray solar daily variation. T. Thambyahpillai and H. Elliot. *Nature* [*London*] **171**, 918–20 (*May* 23, 1953).

It is shown that systematic changes in the phase of the diurnal variation have occurred during the past twenty years at widely separated points on the earth. It is pointed out that if the change is a cyclical one the period is longer than 11 years but might be 22 years. H. Elliot

537.591.5

7775. The penetrating component of cosmic radiation in the upper atmosphere. J. D. Pullar and E. G. Dymond. *Phil. Mag.*, **44**, 565–77 (*June*, 1953).

The vertical intensity of the hard component of cosmic radiation has been measured in geomagnetic latitude 56°, to a minimum atmospheric depth of 4 g/cm². The intensity, determined with a precision of 2·5%, shows no maximum. This agrees closely with the results of Pomerantz [Abstr. 5876 (1952)]. The primary particle flux at this latitude capable of penetrating 90 g/cm² of lead is found to be $0{\cdot}164 \pm 0{\cdot}003$ particle cm^{-2} sec^{-1} ster^{-1}. The flux of μ-mesons in the upper atmosphere has been derived, and shows a maximum of 0·039 particle cm^{-2} sec^{-1} ster^{-1} at a depth of 150 g/cm². Penetrating showers produced in lead have also been measured to a minimum atmospheric depth of 7 g/cm², the primaries being found to have an absorption length of 120 g/cm² of air. A.

537.591.5

7776. Spectral analysis of the [zenith] angle distribution and east-west asymmetry of the nucleonic component of cosmic rays, using nuclear emulsions. Tsai-Chu and M. Morand. *C.R. Acad. Sci.* [*Paris*] **236**, 2311–13 (*June* 15, 1953) *In French.*

537.591.5

7777. High altitude measurements of the intensity of cosmic radiation at magnetic latitudes 3° N and 19° N. A. S. Rao, V. K. Balasubrahmanyam, G. S. Gokhale and A. W. Pereira. Letter in *Phys. Rev.*, **91**, 764 (*Aug.* 1, 1953).

The intensity of the total and the penetrating com-

ponents of the cosmic radiation as a function of height have been measured at the two latitudes using vertical counter telescopes. The penetrating component under 10 cm Pb reaches its maximum at 120 mb pressure and the total intensity at 200 mb for both latitudes. The intensity ratios measured at these pressures are $I(19°)/I(3°) = 1·22$ for the total intensity and 1·46 for the penetrating component. H. ELLIOT

537.591.8

7778. Generation of protons by the neutral component of cosmic radiation. A. KHRIMYAN. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 75–8 (1952) *In Russian.*

This phenomenon, first observed by Alikhanyan in 1949 [Abstr. 1027 (1950)] has been confirmed by more detailed measurements with a large spectrometer in a station at 3250 m. When cosmic rays have passed through 10–13 cm of Pb, 25% of all protons with energies of 80–240 MeV are generated by neutrons, and when they have passed through 20 cm, the figure is 50%. A small number of particles of (apparent) mass 3000–4000 m_e, observed, may represent high-energy protons trapped in the filters by nuclear collisions. R. C. MURRAY

537.591.8

7779. Generation of protons and π-mesons by cosmic neutrons. M. I. DAÏON. *Dokl. Akad. Nauk SSSR*, **86**, *No.* 6, 1093–6 (1952) *In Russian.*

Momenta spectra of protons and π-mesons produced by the neutral component at 3250 m elevation are presented. The data were obtained with a mass spectrometer of high resolving power under 9 cm of Pb. NUCLEAR SCIENCE ABSTRACTS

537.591.8

7780. On nuclear explosions produced by primary protons in emulsions exposed in the high atmosphere. G. CORTINI, A. MANFREDINI AND G. SEGRÉ. *Nuovo Cimento*, **9**, 659–86 (*Aug.*, 1952).

Nuclear explosions produced by cosmic radiation have been studied in Ilford G5, 400 μ emulsions, which were exposed at about 60 g/cm² from the top of the atmosphere for about two hours. The analysis of these stars made it possible to find the characteristics of events produced by primary protons only. The results, compared with theories on meson production, lead to the conclusion that the plural theory is not sufficient to explain the experimental data. It seems probable that the production of mesons should have a fairly high multiplicity even for comparatively low energies (of the order of 5 GeV). On the basis of the comparison of the data with those of other authors, concerning emulsions exposed at 3500 m, a rough scheme of the development of the nucleonic component in the atmosphere is suggested. The high energy part of this component maintains its spectrum approximately and is absorbed with an absorption length of 110 g/cm². A.

537.591.8

7781. On the interaction of cosmic rays with matter under 50 metres water equivalent. E. AMALDI, C. CASTAGNOLI, A. GIGLI AND S. SCIUTI. *Nuovo Cimento*, **9**, 969–1003 (*Oct.*, 1952).

The production of penetrating secondaries by cosmic rays at 50 m w.e. has been investigated by means of a counter hodoscope. The cross-section (in lead) for events which can be interpreted as pai of associated penetrating particles (a.p.p.) is n larger than $(13 \pm 3) \times 10^{-30}$ cm²/nucleon. Such value is deduced from measurements of the corr sponding differential cross-section as a function of th penetration of the secondary particles produce A value of the same order of magnitude is found fc the production of a.p.p. in rock. Furthermore, it shown that the events that can be interpreted a showers penetrating 15 cm Pb, have a frequency tha can be explained, at least in part, as due to purel electromagnetic interaction. Therefore one ca establish an upper limit of a few units in 10^{-} cm²/nucleon for the cross-section for production i Pb of penetrating showers by μ-mesons. Finall events are discussed which appear to be due to a few penetrating particles coming from the rock an it is shown that they can be accounted for by con sidering, besides the production of penetrating shower in rock, the penetrating particles present in the vicinit of the core of extensive air showers. A

537.591.8

7782. Angular distribution of black and grey tracks in stars of average and high energy. G. BELLIBONI AND B. VITALE. *Nuovo Cimento*, **10**, 72–9 (*Jan.*, 1953) *In Italian.*

The angular distributions and angular correlations of the black tracks N ($I/I^0 \geqslant 4·5$) and grey tracks G ($4·5 > I/I^0 \geqslant 2·0$) are analysed for 148 nuclear disintegrations of low (500–700 MeV) and high (800–4000 MeV) energy, observed in Ilford G5 nuclear plates exposed to cosmic radiation. In low-energy stars the following features are noted: the distribution of angles with respect to the vertical is considerably anisotropic even for the low-energy tracks in the stars without a recoil track. The lowest energy tracks are therefore collimated in a downward direction. In the case of stars with a recoil track, the angular distribution is more isotropic. Moreover, for the stars without a recoil track the angles of 90° between the black tracks are abnormally frequent. Therefore there seems to be an intrinsic angular correlation, independent of the latter anisotropy. For the high-energy stars, the anisotropy of the angular distribution of the black tracks seems to decrease as the energy of the stars increases: and the I/I^0 spectrum shows a secondary maximum for $4·5 > I/I^0 > 3·0$. The phenomenological picture is discussed in relation with its possible interpretations. A.

537.591.8

7783. On the growth of a cosmic-ray initiated jet in a nucleus. F. C. ROESLER AND C. B. A. MCCUSKER. *Nuovo Cimento*, **10**, 127–44 (*Feb.*, 1953).

The cascade in the nucleus is investigated with a view to the interpretation of extreme energy stars from heavy nuclei. It is assumed that a clean tunnel is punched through the nucleus and that the cross-section of this tunnel determines the supply of collision partners for the cascade. The tunnel shows a trumpet-like spread but is nearly cylindrically shaped at the highest energies. The spread of the cascade is treated with a diffusion equation of the Fokker–Planck type, considering the second moments. The mass-development is treated by introducing an indeter-

mined function which can be chosen to represent multiple, plural or mixed theories of meson production. The present observational evidence is discussed and shown not yet to decide the choice; experiments which offer no new or special difficulties would probably fix it. A.

537.591.8

7784. On the problem of time delays between cosmic ray particles. A. ROGOZINSKI. *J. Phys. Radium*, **14**, 438–44 (*July–Aug.–Sept.*, 1953) *In French.*

The time delays between the arrival of charged particles produced by the same parent particle, and which lose energy by ionization only, are discussed and it is shown that there is a maximum delay given by $(\Delta t)_{max} \simeq 0{\cdot}6\frac{E_0}{CK_{min}}$ where $E_0 = MC^2$ is the rest energy of the particle and K_{min} is the energy loss per cm of track at minimum ionization in the medium which is assumed to be homogeneous. It is pointed out that this relation between $(\Delta t)_{max}$ and the mass M might serve as a basis for the mass spectrography of high-energy particles. H. ELLIOT

537.591.8

7785. Anisotropic distribution of secondaries in extreme energy cosmic-ray stars. F. C. ROESLER AND C. B. A. MCCUSKER. *Phys. Rev.*, **91**, 690–4 (*Aug.* 1, 1953).

The connection between the conservation law for angular momentum and the anisotropy observed in cosmic-ray stars produced by energetic primaries is investigated. A model is proposed which is probably reasonable for non-central nucleus-nucleus collisions and may have some meaning for nucleon-nucleon collisions; it is based on assuming that the disk-shaped "interaction volume" consists of many zones acting independently. If equilibrium is reached within individual zones, the particles emerging from one zone ought to be distributed isotropically in its centre-of-mass frame. In a non-central collision these frames will in general, in accordance with the conservation of momentum, be different for different zones. Some anisotropy in the total angular distribution follows, but on this model it could never reach the degree frequently observed. A.

MAGNETISM 538

538.083.9

7786. Measurement of magnetic field gradients by nuclear induction [methods]. G. J. BÉNÉ, P. M. DENIS AND R. C. EXTERMANN. *Helv. phys. Acta*, **26**, *No.* 3–4, 267–70 (1953) *In French.*

An extension of earlier work [Abstr. 5563 (1953)] to the measurement of field gradients. In principle grad H determines the shape of the nuclear resonance signal and may be measured by determining the various relaxation times involved. The cases of spherical and axial symmetry are discussed and the case of high field gradients is considered.

E. P. WOHLFARTH

538.1

7787. The motion of a conducting sphere in a uniform magnetic field. D. J. BESDIN, J. R. SHEWELL AND E. IKENBERRY. *Amer. J. Phys.*, **21**, 418–21 (*Sept.*, 1953).

The motion of an uncharged, homogeneous, solid conducting sphere in a uniform, static field of magnetic induction **B** is determined in terms of the initial velocity of the centre of mass, the initial angular velocity ω_0, and the time. It is found that the component of the velocity of the centre of mass in the direction of **B** is constant, whereas the components perpendicular to the field are damped exponentially; the angular velocity vector is always in the plane of **B** and the initial angular velocity vector ω_0, but its magnitude is damped exponentially, with the component parallel to **B** being damped twice as rapidly as the component perpendicular to **B**. The motion in space of axes fixed in the sphere is determined in terms of solutions of the Weber equation. A.

538.114

7788. Spatial correlations of the noise of cyclic magnetization reversal. A. A. GRACHEV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 741–4 (1952) *In Russian.*

A continuation of previous work [Abstr. 5944 (1950)]. The coeff. of correlation k between the noise at two points in the coil producing cyclic magnetization reversal is calculated as $k = \bar{u}_1\bar{u}_2/(\bar{u}_1\bar{u}_2)^{\frac{1}{2}}$, where $\bar{u}_1$, $\bar{u}_2$, are the r.m.s. potentials produced at the output of a heterodyne filter into which the induced e.m.f.'s being investigated are fed. For the longitudinal correlation along the length of a ferromagnetic wire it was found that $k = \exp[-(x+a)/\lambda]$, where x = distance between the points investigated, and λ = a const., which = 6 mm for unannealed, and 19 mm for annealed Permalloy. When two ferromagnetic wires are laid parallel to one another at distance D apart, k was found to decrease as D increases. When a number n/λ of such identical wires are laid parallel to one another, it was found that the amplitude V of a discrete line (8·7 kc/s) in the noise increased linearly with n, while $\bar{u}^2$ increased at a slower rate than n, showing that the signals given by the individual wires are not statistically independent.

R. C. MURRAY

538.12

7789. The external magnetic field of a single thick semi-infinite parallel plate terminated by a convex semi-circular cylinder. N. DAVY AND N. H. LANGTON. *Quart. J. Mech. appl. Math.*, **6**, 115–21 (*March*, 1953).

The theory of the external field of a common type of electromagnet polepiece is derived. Numerical tables and a graph illustrate the field strength variation. Some of the results may be of interest in molecular beam work. A.

538.12 : 621.3.013 : 621.318.4

7790. The construction of small solenoids for the production of intense magnetic fields. W. R. MYERS. *J. sci. Instrum.*, **30**, 237–8 (*July*, 1953).

The construction of some small solenoids is described and their behaviour in the production of intense transient magnetic fields of up to 250 kOe is reported. With applied voltages of up to 14 kV from a 4·5 μF condenser, none of the solenoids experienced either electrical or mechanical breakdown. A.

538.221/.222

7791. Magnetic properties and electron distribution in some alloys and compounds. G. Foëx. *Helv. phys. Acta*, **26**, *No.* 3–4, 199–206 (1953) *In French.*

A review of the uses of magnetic measurements in elucidating the electronic structure of solids. Examples given include: (1) alloys of nickel with diamagnetic metals (Sadron); (2) alloys of palladium with diamagnetic metals (Wucher) [Abstr. 8323 (1952)]; (3) Ni–La alloys (Wucher) [Abstr. 7391 (1952)]; (4) several paramagnetic compounds ($CrSi_2$, $MnSi_2$, $FeSi_2$, $CoSi_2$, NiAs, FeS_2). E. P. WOHLFARTH

538.221

7792. Metallic dysprosium and its magnetic properties. F. Trombe. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 61–70 (*June*, 1953) *In French.*

A review of methods of preparation of rare earth metals is followed by a description of the method used for preparing dysprosium specimens. Results of susceptibility measurements are given, covering the temperature range up to 300°K and magnetic fields up to $7{\cdot}8\times10^3$ oersted. The results have been summarized previously [Abstr. 4904 (1953)].

E. P. WOHLFARTH

538.221 : 538.662 : 621.318.1

7793. On the temperature sensitivity of special magnetic materials. T. A. Heddle. *Brit. J. appl. Phys.*, **4**, 161–6 (*June*, 1953).

A description is given, in survey form, of magnetic materials which are sensitive to temperature in the range −60 to +120°C. Applications of these materials to temperature detecting and compensating devices are also considered. 40 refs. A.

538.221 : 538.662.15

7794. Thermomagnetic properties of rhombohedral ferric oxide H. Bizette, R. Chevallier and B. Tsaï. *C.R. Acad. Sci.* [*Paris*] **236**, 2043–5 (*May* 27, 1953) *In French.*

Describes results of measurements on two natural haematite crystals at temperatures between 73° and 293°K and in fields up to $2{\cdot}2\times10^4$ oersted. The transformation region extends over the range 173° to 253°K. Above 253°K $\chi_{\|}$ is independent of field and the magnetization normal to the ternary axis is given by $\sigma = \sigma_0 + \chi_{\perp}H$, with $\chi_{\|} = 22{\cdot}0\times10^{-6}$, $\chi_{\perp} = 20{\cdot}2\times10^{-6}$, $\sigma_0 = 0{\cdot}39$. Below 173°K $\chi_{\|} = 0$, $\chi_{\perp} = 22{\cdot}9\times10^{-6}$, $\sigma_0 = 0$. The results are contrasted with those of Abstr. 6625 (1952). E. P. WOHLFARTH

538.222

7795. Rb^{87} and Cs^{133} magnetic resonance shifts in the solid halides. H. S. Gutowsky and B. R. McGarvey. Letter in *J. chem. Phys.*, **21**, 1423–4 (*Aug.*, 1953).

The chemical shifts of the Rb^{87} and Cs^{133} magnetic resonances in the solid halides are tabulated, the saturated aqueous solution of the corresponding chloride being used as reference. The magnetic shielding of the alkali metal nucleus decreases from fluoride to iodide, whilst the Cs shifts are larger than those of Rb. G. I. W. LLEWELYN

538.222

7796. Nuclear magnetic resonance in solid hydrogen. F. Reif and E. M. Purcell. *Phys. Rev.*, **91**, 631–41 (*Aug.* 1, 1953).

The fine structure of the nuclear magnetic resonance line in solid hydrogen at low temperatures (1·15°) was studied experimentally using a recording met technique. The observed line shape can be explaine quantitatively by the magnetic dipole interaction the two protons in a hydrogen molecule, provided on takes into consideration the effect of the crystalli potential responsible for lifting the rotation degeneracy of the *ortho*-molecules in the soli Extremely general assumptions concerning the natu of this crystalline potential are sufficient to accou for the nuclear resonance data; in particular, one ca treat the case where this potential, by virtue of th random mixture of *ortho*- and *para*-molecules in th solid, is not symmetric and not the same at th positions of different *ortho*-molecules. An appare hysteresis effect in solid hydrogen was observed ar some experiments were also performed on sol HD and D_2. The general theory developed in co nection with the foregoing experiments also predic the detectability in solid hydrogen of a resonan line in zero external magnetic field, this line co stituting a direct measure of the dipole interactic responsible for the fine structure of the resonance lin in high fields. Despite experimental difficulti peculiar to the zero-field experiment, this resonan line was found at the expected frequency of abo 165 kc/s.

538.22

7797. The magnetic properties of certain rare-ear ethyl sulphates. R. J. Elliott and K. W. H Stevens. *Proc. Roy. Soc. A*, **219**, 387–404 (*Sept.* 2 1953).

The theory of the magnetic properties of rar earth ions in crystals, which has been developed i preceding papers [Abstr. 3765 (1952); 2545 (1953 6950 (1953)], is here applied to the ethyl sulphate The magnetic resonance and susceptibility results a discussed at length, and it is shown that the obse vations can be explained by using fields of C_{3h} sym metry which vary in a systematic way as one rar earth ion is replaced by another.

538.222 : 541.6

Dimerization in NaF. *See Abstr.* 8039

538.22

7798. Magnetic anisotropy of several organi crystals at low temperatures. N. Lumbroso an H. François. *C.R. Acad. Sci.* [*Paris*] **236**, 2308– (*June* 15, 1953) *In French.*

Reports measurements of the changes of the mag netic anisotropy values of the following aromati substances as the temperature is lowered from roo temp. to that of liquid nitrogen: *p*-dibromobenzen *p*-benzoquinone, naphthalene, dibenzyl, stilben azobenzene. E. P. WOHLFART

ELECTROMAGNETISM . ELECTRODYNAMIC 538.3/.5

538.522 : 621.3.014.

7799. On the current induced in a conducting ribbo by a current filament parallel to it. E. B. Moullin *Instn Elect. Engrs Monogr. No.* 71, 11 *pp.* (*Aug.* 15 1953) [To be published also in *Proc. Instn Elect Engrs IV*].

A continuation of a previous paper [Abstr. 373

952)]. The distribution of the induced current is evaluated when the cylindrical source is distant d from a half-plane and distant h from its boundary edge, for 3 cases (i) $d = \lambda/4$, $h = 0{\cdot}592\,\lambda$, (ii) $d = 0{\cdot}96\,\lambda$, $h = 0{\cdot}555\,\lambda$, (iii) $d = \frac{1}{2}\lambda$, $h = 0{\cdot}99\,\lambda$. In each case the disturbance of density is found to be concentrated in a width of about $0{\cdot}1\lambda$ from the bounding edge. Next it is shown that the calculable edge effects appropriate to a half-plane provide a very close solution for a ribbon of finite width, and that the diffraction pattern for a filament in the presence of an infinite conducting plane depend primarily on the currents induced in a width of about $\pm\lambda$ from the foot of the perpendicular. The effect on diffraction patterns of edge effects due to the finite width of the reflector are found to be negligible. On the basis of these results a practical principle is suggested: that the diffraction pattern for a filament and reflector of finite width can be closely estimated by assuming the reflector to have the currents which would be induced in the same width of an infinite plane. L. S. GODDARD (R)

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.566 : 621.392.26

7800. Surface wave propagation over a coated conductor with small cylindrical curvature in direction of travel. K. HORIUCHI. Letter in *J. appl. Phys.*, **24**, 961–2 (*July*, 1953).

The theoretical analysis of the field in the neighbourhood of a bend in the surface wave and, in particular, the deviation of the TM-wave [see Abstr. 4545 (1951)] over the coated plane conductor is considered. A bend in the Gobau line introduces attenuation and leads to intensification of the field on the outside; this has been verified experimentally and supported by data. Z. F. WOJNAR

538.566

7801. The diffraction of a dipole field by a perfectly conducting half-plane. T. B. A. SENIOR. *Quart. J. Mech. appl. Math.*, **6**, 101–114 (*March*, 1953).

The field components are obtained by a method which is valid for all positions of the dipole and which is based on the resolution of the dipole field into plane waves whose diffraction by the sheet may be studied independently. The case of a dipole with axis normal to the half-plane is considered in detail. A.

538.566

7802. Diffraction theory: A critique of some recent developments. C. J. BOUWKAMP. *New York Univ. (Washington Sq. Coll.) Math. Res. Group, Res. Rep., No.* EM.50, 91 *pp.* (*April*, 1953).

A number of recent developments in the theory of diffraction of electromagnetic waves, particularly those dealing with apertures in plane conducting screens, are reviewed. The subjects treated include modifications of Kirchhoff's theory, the theory of small apertures, Babinet's principle for plane obstacles, variational principles, and singularities at sharp edges. For completeness, a discussion from an alternative viewpoint of the problem of diffraction by an aperture by N. Marcuvitz has been included in this report. A.

538.566 : 621.3.017 : 621.315.61 : 621.392

7803. Effect of particle size on magnetic loss tangent of obstacle type artificial dielectrics. J. M. KELLY AND J. O. STENOIEN. Letter in *J. appl. Phys.*, **24**, 962–3 (*July*, 1953).

The magnitude of the loss tangent for particles of a given metal powder depends on the average size of the particles. Using two aluminium powders, Alcoa No. 322 and Alcoa No. 422 and wax as binder it was shown that the smaller particle yields an artificial dielectric with smaller magnetic loss. The appended graph shows a linear relation between the magnetic loss tangent and powder concentration for two sizes of aluminium flakes. Z. F. WOJNAR

538.566.2 : 621.396.11

7804. The propagation of very low frequency radio waves to great distances. K. G. BUDDEN. *Phil. Mag.*, **44**, 504–13 (*May*, 1953).

In discussing the propagation of v.l.f. radio waves to great distances, it is convenient to treat the space between the earth and the ionosphere as a waveguide. This treatment is applied to some experimental measurements made on signals of frequency 16 kc/s, over distances of 340–3640 km from the sender. It is shown that the measurements can be explained in terms of the four least attenuated waveguide modes. If the earth's magnetic field is neglected, and the ionosphere is assumed to be a sharply bounded homogeneous, ionized medium, then it is shown that the height of the boundary is $69{\cdot}1 \pm 0{\cdot}5$ km. A.

538.566.2 : 535.312 : 534.24

7805. Reflection of waves from varying media. C. O. HINES. *Quart. appl. Math.*, **11**, 9–31 (*April*, 1953).

Formulae are found for the coefficient of reflection from varying media of a type encountered in physics. These are applied approximately for some general classes of media, and exactly for some specific cases. Many media which would normally be expected to be highly reflecting are shown to be completely transparent to certain waves at least and, in some cases, to a whole spectrum of waves. The results are considered both for electromagnetic (or other classical) waves and for mass waves. A.

538.566.2 : 621.396.11 : 621.396.822

7806. Atmospherics with very low-frequency components. F. HEPBURN AND E. T. PIERCE. *Nature [London]* **171**, 837–8 (*May* 9, 1953).

Observations of the l.f. "slow tail" component in the wave-form of atmospherics shows that, on the average, both the time occupied by the first quarter-period of the tail and the time interval between the start of the main oscillatory section of the atmospheric and the commencement of the tail increase in a linear manner with the distance of origin of the atmospheric; the rate of increase being significantly different by day and by night. Assuming a waveguide model for propagation (perfectly conducting earth, ionosphere of conductivity σ, at height h) estimates are made as follows: $\sigma = 5\times10^3$ e.s.u. (day), 11×10^3 e.s.u. (night); $h = 65$ km (day), 90 km (night). G. M. BROWN

538.566.3

7807. Contribution to the calculation of absorption in the ionospheric propagation of short waves. A. BOLLE AND P. DOMINICI. *Ann. Geofis.*, **5**, 377–96 (*July*, 1952) *In Spanish.*

Mathematical considerations, developing expressions for the absorption coefficient for short waves propagated in the various ionospheric layers. The influences of charged particles, and magnetic and electric fields are considered, and the results applied to the various modes of propagation of the waves.

G. M. BROWN

538.566.3

7808. Propagation of plane electromagnetic waves in the ionosphere. R. JANCEL AND T. KAHAN. *C.R. Acad. Sci.* [*Paris*] **236**, 2045–7 (*May* 27, 1953) *In French.*

Assuming an ionized layer characterized by a certain dielectric tensor, expressions are derived for the attenuation, group velocity and polarization of plane electromagnetic waves propagated therein. The layer shows birefringence, and expressions are given for the refractive index for the cases of propagation along and perpendicular to the magnetic field. G. M. BROWN

MAGNETIC EFFECTS 538.6

538.614

7809. Magnetic rotatory powers of krypton and xenon. R. DE MALLEMANN, F. SUHNER AND J. GRANGE. *C.R. Acad. Sci.* [*Paris*] **236**, 2366–7 (*June* 22, 1953) *In French.*

The atomic rotations of Kr and Xe at 18°c for yellow radiation 5780 Å are given and compared with previously recorded values for the other rare gases.

G. I. W. LLEWELYN

538.614

7810. Optical activity of the bromide of cobalt III triethylene diamine in the crystalline state and in solution. E. DROUARD AND J.-P. MATHIEU. *C.R. Acad. Sci.* [*Paris*] **236**, 2395–7 (*June* 22, 1953) *In French.*

The coefficient of molecular absorption, the magnetic rotatory power, and the ellipticity of $Br_3[Co(C_2N_2H_8)_3]2H_2O$ in the crystalline state along the optical axis and in solution in water (0·04 moles/litre) are tabulated for the frequency range 0·440–0·589 μ. Comparison of the Cotton effect of the solution and of the crystal shows the effect of anisotropy and of the crystalline field on the optical activity. G. I. W. LLEWELYN

538.652 : 538.221

7811. Dynamical physical parameters of the magnetostrictive excitation of extensional and torsional vibrations in ferrites. C. M. VAN DER BURGT. *Philips Res. Rep.*, **8**, 91–132 (*April*, 1953).

Extensional and torsional vibrations can be easily excited magnetostrictively in non-conducting ferromagnetics like ferrites. A simple experimental method permits rapid determination of the dynamic elastic and magnetoelastic constants, the complex nature of which is discussed after a comprehensive survey c the four sets of simultaneous magnetostrictio equations of interest under adiabatic conditions an under arbitrary depolarization. In reasonable agree ment with the theory the stress-sensitivity constan and the magneto-mechanical coupling coefficient c several NiZn ferrites proved to be of the same ord of magnitude as those of metallic "magnetostrictiv materials" in common use. Moreover these ferrite (Ferrox-cube-IV materials) show much lower elasti dissipation at ultrasonic frequencies. Mechanical factors up to 15 000 have been obtained at 50 kc/s The variation of elastic and magnetic lag with fre quency and biasing polarization is discussed. A considerable part of the total elastic losses at optimur bias consists in macro magnetoelastic losses accom panying the macro polarization induced magneto strictively. The experimental correlation between th conductivity and the elastic and magnetic losses i explained in terms of elastically and magneticall excited micro strains that give rise to an electroni diffusion process. The order of magnitude of th molecular field is derived from the influence of th magnetocaloric effect on the magnetoelastic constant near saturation. A

MOLECULAR AND ATOMIC STRUCTURE 539.

THEORY OF SOLID STATE 539.11

539.11

7812. Statistical theory of rotational phase transi- tion. II. T. OGUCHI. *J. Phys. Soc. Japan*, **8**, 142–8 (*March–April*, 1953).

For Pt I, see Abstr. 7441 (1952). Rotational phase transitions in the dipolar molecular crystals are dis- cussed. In these crystals, the molecules are under the dipole-dipole interactions between them. The dipole-dipole interactions are simplified as follows: the interaction potential between two neighbouring molecules along x or y axis is $(J/4)\cos(\omega, \omega')$ and that along z axis is $-(J/2)\cos(\omega, \omega')$, where (ω, ω') is the angle of the orientations of the dipole moments and J is the positive constant. Due to this potential, the dipoles are arranged parallel to each other along z axis and anti-parallel along x and y axis at lower temperatures. The equilibrium state is obtained by solving the non-linear integral equation, which is constructed by minimizing the free energy at the stage of the Bethe approximation, and the transition point is determined from the branching point of this integral equation. A.

539.11

7813. Interionic forces in metals. A. HERPIN. Letter in *J. Phys. Radium*, **14**, 349–50 (*May*, 1953) *In French.*

With a simple model for the forces between ions, the velocity of propagation of longitudinal vibrations has been calculated as a function of wave number. Reasonable agreement with experiment has been obtained. P. T. LANDSBERG

539.11

7814. A study of Vegard's law. G. FOURNET. *J. Phys. Radium*, **14**, 374–80 (*June*, 1953) *In French.*

The energy E of a solid solution is expressed as the sum of the interaction energies between pairs of atoms. The equilibrium lattice spacing r is obtained from the condition $\partial E/\partial r = 0$. Two cases are considered, that of an ideal solid solution and of a solution in which short-range order exists. In the first the deviations from Vegard's law are simply related to the ratio $C = \alpha_A/\alpha_B$, where $\alpha_B = r_B/\beta_B$, β_B being the compressibility of pure B and r_B its interatomic spacing. When $r_A < r_B$ positive deviation from Vegard's law corresponds to $C > 1$ and negative deviation to $C < 1$. Observed behaviour is in general agreement with this result. In the second case an expression is derived for r which differs from that for the ideal solution in containing an additional term F depending on the ordering energy. When F is small compared to C the ideal solution case is a sufficiently good approximation. The expression obtained for r can, by suitable choice of F, be well fitted to observed variations of r with composition. Such empirically determined F values are given for Au/Ag and Pt/Au solutions and their magnitude and sign justified by direct calculations of F, using values of the interaction energies between pairs previously derived from studies of order-disorder phenomena in these or closely similar alloys. A. D. LE CLAIRE

539.11

7815. The electrostatic energy of boron nitride. W. M. LOMER AND K. W. MORTON. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 772–3 (*Aug.* 1, 1953).

A modification of Ewald's method for calculating the Madelung constant has been used to obtain the electrostatic interaction of the layers in BN. The maximum difference between a graphite form of layer packing and the observed packing is 0·077 kg cal mole^{-1}, which is likely to be smaller than other possible interlayer interactions. R. S. PEASE

539.11 : 536.48 : 537.32

Thermo-electricity at low temperatures. I. The "ideal" metals: sodium, potassium, copper. *See Abstr.* 7690

539.11 : 537.311.31

7816. Atomic distribution in binary solid solutions. IV. The influence of the short-range order on the electrical resistivity of alloys. T. MURAKAMI. *J. Phys. Soc. Japan*, **8**, 458–62 (*July–Aug.*, 1953).

For Pt III, see Abstr. 2585 (1953). The temperature dependence of the additional resistivity of binary alloys due to the presence of the short-range order is calculated by means of the pair distribution functions of atoms over crystal lattices, whose analytical expressions are given in the previous parts of this series. The present method used in deriving the expression for the resistivity in alloys is almost similar to the one which has already been developed by Nordheim, who has, however, ignored contribution of the short-range order to the resistance of alloys, and therefore obtained the additional resistivity independent of the temperature. The actual calculation is performed only for simple cubic alloys to avoid computational difficulties. According to the result of calculation, the decrease in the resistivity due to the short-range order becomes appreciable at temperatures immediately above the order-disorder transition point, and, indeed, this contribution decreases the additional resistivity by about 20% compared with the one obtained in the completely random case, even at the temperature 30°c above the critical temperature, if the present theory is applied to the case of Cu_3Au alloy. A.

539.11 : 537.311.31

7817. Some difficulties of the electron theory of metals. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **236**, 2391–3 (*June* 22, 1953).

Experimental results on the temperature coefficient of resistance of alloys of Al–Cu and Cu–Zn at various temperatures in both the solid and liquid states are reported and briefly explained by assuming a dissociation of atoms and a consequent liberation of conduction electrons. C. A. HOGARTH

MOLECULAR STRUCTURE 539.13

539.13

7818. On the theory of the HI molecule. R. GÁSPÁR AND A. KÓNYA. *Acta phys. Hungar.*, **3**, *No.* 1, 31–44 (1953) *In German.*

This theory is developed on the assumption that the molecule consists of an I^- ion and a proton. Perturbation calculations are carried out, suitable for the statistical model of the I^- ion with correlation correction. No empirical constants are introduced. The agreement with experimental data is good for binding constants, dissociation energy and induced dipole moment. J. JACOBS

539.13 : 537.226

7819. Intermolecular potentials from dielectric polarization in polar gases. F. E. HARRIS AND B. J. ALDER. *J. chem. Phys.*, **21**, 1351–7 (*Aug.*, 1953).

A theory which relates the dielectric polarization of polar gases to the intermolecular potential is formulated. In it occurs an expansion in powers of $1/V$, analogous to the virial expansion. The convergence of this series is briefly discussed, and the impossibility of rotational transitions in the gas phase is shown. Evaluation is limited to the leading term of the expansion, which involves interactions of a pair of molecules only and which is calculable from a knowledge of the intermolecular potential. Various intermolecular potentials consistent with virial data are introduced, and the results are compared with experiment for ammonia, methyl fluoride and hydrogen fluoride. In view of the unsatisfactory precision of the experimental data, the agreement is as good as can be expected and is qualitatively in agreement with previous concepts of the strength and nature of the hydrogen bond. A.

539.13 : 541.64

Effect of intermolecular attraction on the strength of high polymers with developed spatial structure. *See Abstr.* 8040.

539.132

7820. Centrifugal distortion effects in methyl chloride. T.-S. CHANG AND D. M. DENNISON. Letter in *J. chem. Phys.*, **21**, 1293 (*July*, 1953).

Using molecular potential constants evaluated from new experimental data, the centrifugal distortion constants of CH_3Cl^{35} and CH_3Cl^{37} are calculated. The values so obtained are in reasonably good agreement with the corresponding experimental values.

G. I. W. LLEWELYN

539.132

7821. Normal coordinate analysis of CF_3CH_3 based on a Urey–Bradley potential function. CHI YUAN PAN AND J. R. NIELSEN. Letter in *J. chem. Phys.*, **21**, 1426–7 (*Aug.*, 1953).

Assuming the eclipsed structure for the CF_3CH_3 molecule, the force constants calculated by a treatment based on a mathematically cumbersome but physically more precise potential function [Urey and Bradley, *Phys. Rev.*, **38**, 1969 (1931)] agree well with those obtained by the usual potential function.

G. I. W. LLEWELYN

539.132

7822. The separation of the rotational coordinates from the *N*-particle Schroedinger equation. II. C. F. CURTISS. *J. chem. Phys.*, **21**, 1199–208 (*July*, 1953).

For Pt I, see Abstr. 2891 (1951). Group theoretical methods are used to separate the rotational co-ordinates from the *N*-particle Schroedinger equation and obtain a set of equations which are particularly applicable to the study of collisions involving two sets of particles or two molecules. The co-ordinates used to describe the configuration of the *N* particles in a centre of gravity co-ordinate system are those describing the orientation of the system as a whole, the relative orientation and separation of the two molecules, and the internal configuration of each of the molecules. Coupled differential equations involving only the co-ordinates describing the internal configuration and separation of the molecules are obtained. As a special case the equations are applied to a system consisting of two diatomic molecules. A.

539.132

7823. A method for computing zero-point energies. P. W. HIGGS. Letter in *J. chem. Phys.*, **21**, 1300 (*July*, 1953).

The zero-point energy E_0 of vibration of a polyatomic molecule is usually determined from the roots of the secular equation for the frequencies $|GF - \lambda I| = 0$, where F and G are the potential and inverse kinetic energy matrices. The formula $E_0 = \hbar/2$ trace $(GF)^{1/2}$ is deduced by matrix algebra, and provides a means of calculating E_0 from the geometry and force constants. An iteration process for the practical solution of this problem is proposed.

H. H. GREENWOOD

539.132

7824. A study of spin-spin coupling in the quadrupole resonance of nitrogen. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **236**, 2232–4 (*June* 8, 1953) *In French.*

One may expect that the spin-spin effect should be the main cause of the broadening of the quadrupole absorption line in N. To check this suggestion, theoretical treatments are given for $C_6H_{12}N_4$ and ICN. The values of the breadth calculated on the above hypothesis are in agreement with experimental data.

L. PINCHERLE

539.132

7825. On a corpuscular image and matrix extension of the wave method of molecular orbitals. F. ROGER. *C.R. Acad. Sci.* [*Paris*] **236**, 2207–9 (*June* 8, 1953) *In French.*

The method of "coupling of constituents" is an extension of the wave mechanical molecular orbital picture. It consists of discussing certain properties of a chemical compound by imagining it split into constituents, not necessarily individual atoms with π electrons, the coupling between these suitable groupings being expressed in terms of matrices. This is achieved by associating the equations of small displacements in classical mechanics with those of molecular orbitals. J. JACOBS

539.132

7826. A united-atom treatment of conjugated systems. R. D. BROWN AND F. A. MATSEN. Letter in *J. chem. Phys.*, **21**, 1298–9 (*July*, 1953).

A molecular orbital is written as a linear combination of united-atom orbitals located in each bond (LCUAO MO approx.). The bond order is then expressed in terms of the squares of the coefficients relevant to the chosen bond summed over the occupied orbitals. This contrasts with the conventional LCAO MO method in which the bond order is defined as the sum of the products of pairs of coefficients relating to the atomic orbitals at either end of the bond concerned. Numerical examples of both methods are compared, and a general formula for the LCUAO MO bond order in polyenes is presented.

H. H. GREENWOOD

539.133 : 548.736.3

The crystal and molecular structure of B_4Cl_4. *See Abstr.* 8103

539.133 : 548.737

The crystal and molecular structure of 1, 2-dichloroethane at −140°C. *See Abstr.* 8115

539.133 : 535.343.4–14

Microwave investigation of pyridine. *See Abstr.* 7573

539.133 : 535.343.4–15

Rotation vibration bands of some symmetric top molecules under high resolution. *See Abstr.* 7580

539.133

7827. Dipole moments of organic acids deduced from adsorption measurements at the surface of polarized mercury. R. GRAND. *J. Phys. Radium*, **14**, 225–35 (*May*, 1953) *In French.*

The surface adsorption, surface tension and electrocapillary current vary with the pH of an acid solution. The electric surface charge can be estimated from these variations and the amount of adsorbed oxygen can be found oscillographically. For a certain acidity no oxygen is present in the surface region. On the assumption that in this case adsorption of acid radicals is preferential, the average dipole moment of the layer can be calculated. A. J. TAYLOR

539.133

7828. Some dimensions of long chain linear molecules. J. J. WEIDMANN, H. KUHN AND W. KUHN. *J. Chim. phys.*, **50**, 226–35 (*April*, 1953) *In French.*

A long chain molecule is represented by a system of N elements of equal length A forming a broken chain in which the direction of any element is independent of that which precedes or of that which follows it. All elements must, however, be parallel to a co-ordinate xyz axis. It is then possible to derive a differential equation for the probability that a molecule having one end in a given domain shall lie entirely within that domain. The solution yields several interesting results, and in particular the probability function for the projection of the molecule along any axis from which the mean $\overline{X} = 0{\cdot}92\sqrt{(NA^2)}$ and the r.m.s. projection $\sqrt{(\overline{X^2})}$ may be determined. These are simply related to the mean projection $\overline{h}_x$ along the same axis, and the r.m.s. $\sqrt{(\overline{h^2})}$ of the distance between the two ends of the molecule. In a similar way, the probability function for the position R of the point most remote from one end of the molecule is derived, and from it the mean $\overline{R}$ and r.m.s. $\sqrt{(\overline{R^2})}$ are deduced. These are also simply related to $\overline{h}$ and $\sqrt{(\overline{h^2})}$. The related means are of the same orders of magnitude. H. H. GREENWOOD

539.133 : 530.162

Statistical mechanics of interacting dipoles. *See Abstr.* 7473

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1/.2

7829. The hyperfine structure and nuclear moments of Pr^{141}. HIN LEW. *Phys. Rev.*, **91**, 619–30 (*Aug.* 1, 1953).

The hyperfine structure of the ground state of Pr^{141} has been studied by the atomic beam magnetic resonance method. It has been established that the electronic ground state of Pr is $4f^3 6s^2$, $^4I_{9/2}$. Of the five hyperfine intervals arising from this electronic state and a nuclear spin of 5/2, the lowest two have been observed. They are $W(F=4) - W(F=3) = 3708{\cdot}05$ Mc/s and $W(F=3) - W(F=2) = 2782{\cdot}25$ Mc/s. If the h.f.s. is assumed to be entirely due to an interaction between the $^4I_{9/2}$ state and the nucleus, the observed intervals may be expressed in terms of a magnetic dipole interaction constant A and a nuclear electric quadrupole interaction constant B. It is found that $A = 926{\cdot}03 \pm 0{\cdot}1$ Mc/s and $B = -13{\cdot}9 \pm 1{\cdot}0$ Mc/s. From these constants, the nuclear moments have been evaluated by means of approximate methods. The values obtained are $\mu = +3{\cdot}8$ mm, $Q = -0{\cdot}054 \times 10^{-24}$ cm^2. A.

539.152.1

7830. Application of the self-adjusting field method to the nucleus. A. KOMPANEETS. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 2, 301–4 (1952) *In Russian.*

It is shown that the method can explain, in very general terms, the approximate constancy of the energy and volume associated with a single nucleon.

R. C. MURRAY

539.152.1

7831. The energy levels of heavy nuclei. F. FERRARI AND C. VILLI. *Nuovo Cimento*, **9**, 927–39 (*Oct.*, 1952) *In Italian.*

The level density of a standard heavy nucleus is calculated taking into account the modifications brought about by nuclear interactions in the Fermi gas model. Their effect on the energy-temperature dependence is evaluated by the relation $\tau = T + a\psi(\tau)$ between the equivalent temperature τ and the true temperature T. The energy-temperature relation may be derived either on the basis of the exact Fermi expressions for the number of particles and their total energy or modifying the coefficient b of the law $E = bT^2$, which may be written in the form $E = B(a, T)T^2$. The function $B(a, T)$ depends strongly on the parameter a and is slowly varying with temperature in the energy range, $0 \leqslant E < 10$ MeV, with which the calculations are concerned. The parameter a is closely related to the thermonuclear energy as expected from Watanabe's ratio $K^{(2)}/K^{(0)} = 0{\cdot}34$. Its value was found to be $0{\cdot}35$ instead of $0{\cdot}29$ as given by him; such difference is due to the fact that exact expressions of Fermi statistics have been used throughout instead of the approximate ones in the equivalent temperature region. The energy levels have been calculated with Bethe's formula taking into account modified expressions for the nuclear specific heat and entropy. The mean value of $B(a, T)$, in the energy region considered, agrees fairly well with Bardeen's predictions, although derived on substantially different assumptions. Calculated energy levels are compared with other theoretical predictions and with experimental values observed for Pd^{103}. The agreement with the liquid drop model is briefly discussed. A.

539.152.1

7832. The analysis of nuclear excited states [for $20 < Z < 70$] by means of the shell model. L. K. PEKER, L. A. SLIV AND A. V. ZOLOTAVIN. *Dokl. Akad. Nauk SSSR*, **88**, *No.* 5, 781–4 (1953) *In Russian.*

Some results of attempts to construct level schemes on the basis of the shell model and experimental evidence from energies, the multipole character of γ's, β-spectra and γ–γ and γ–β correlations. Diagrams for Cs^{131}, Xe^{131}, Mo^{95} are given. The deduced spin-orbit coupling (300–700 keV) seems to be independent of l and the nuclear radius. W. J. SWIATECKI

539.152.1

7833. On the theory of the isotopic shift. D. IVANENKO AND N. KOLESNIKOV. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 253–6 (1953) *In Russian.*

The local irregularities in the plot of the isotopic shift against A may be due to the influence of closed shells on the nuclear radius. No quantitative interpretation is given. W. J. SWIATECKI

539.152.1

7834. Liquid drop behaviour of an independent particle nuclear model. S. GALLONE AND C. SALVETTI. *Nuovo Cimento*, **10**, 145–50 (*Feb.*, 1953).

The behaviour of a particular independent particle nuclear model has been studied in order to investigate the nature of the asymmetric models. It is shown that the asymmetry is not strictly related to the assumption

of a Rainwater type model [Abstr. 8911 (1950)]. Moreover analogies in the behaviour of the shell and liquid drop models are indicated and a limitation to the liquid drop description is shown. A.

539.152.1

7835. Effect of nuclear structure on the statistical law for the binding energies. R. Bouchez, J. Robert and J. Tobailem. *J. Phys. Radium*, **14**, 281–94 (*May*, 1953) *In French.*

An empirical study of the modifications to be applied to the parabolic (Bethe–Weizsäcker) law to obtain a monotonic variation of suitable parameters. The discontinuities of these parameters represent the effect of nuclear shells or subshells, of the binding energy of a nucleon pair or of an α-group. This modified statistical law is useful as a method of analysis and classification, but does not give with precision the binding energies of individual nuclei.

L. PINCHERLE

539.152.1

7836. Difference between the density distribution of neutrons and protons in atomic nuclei. P. Gombás. Letter in *Nature* [*London*] **171**, 979–80 (*May* 30, 1953).

A variational calculation based on the Thomas–Fermi gas model with a Yukawa interaction taken to 1st order and with Weizsäcker and Coulomb exchange terms included gives nearly Gaussian radial distributions for both neutrons and protons. [See Abstr. 2605 (1953)]. W. J. Swiatecki

539.152.1

7837. Pairing energy in the *j–j* coupling model. A. J. M. Hitchcock. *Phil. Mag.*, **44**, 766–71 (*July*, 1953).

The pairing energy of two nucleons of the same kind in a shell has been calculated. Harmonic oscillator wave-functions and very short-range nuclear forces were assumed. It is found that the empirical predictions of Mayer [Abstr. 6007 (1950)] are verified in all cases but one and that the exception accounts for the anomalous spin of Ba^{137}. Certain new peculiarities are predicted (e.g. in quadrupole moments and the spin of F^{19}) which are found to be in satisfactory agreement with experiment. The averaged variation of pairing energy with A is found not to agree with Bohr and Wheeler's semi-empirical formula. A.

539.152.2

7838. On the spin of certain odd-odd nuclei. I. General formulae. C. Marty, R. Nataf and J. Prentki. *C.R. Acad. Sci.* [*Paris*] **236**, 2387–9 (*June* 22, 1953) *In French.*

A theoretical study, on the basis of the shell model, of nuclei with one proton and one neutron outside closed shells. The methods developed by Racah for atomic spectra are applied to the most general central interaction between the two particles.

L. PINCHERLE

539.152.2

7839. Nuclear signals dependence on the radio-frequency field and paramagnetic catalyst. G. Chiarotti and L. Giulotto. *Nuovo Cimento*, **10**, 54–71 (*Jan.*, 1953).

An apparatus for nuclear signal amplitude measurement is described. With this arrangement measurements of absorption signal amplitude from proton contained in aqueous solutions of ferric nitrate at various concentrations and various radiofrequency field values have been carried out. In order to explain the results obtained, an approximate theory of nuclear magnetic resonance is developed assuming that the surplus of spins in the lower states is uniformly distributed over a certain frequency range. The theory takes into account the "memory" effects that occur when the thermal relaxation time is of the order of the sweep period. In this way a general formula is obtained which gives the energy absorbed during a passage. The experimental results agree satisfactorily with this theory. The comparison of experimental results with theory enables one to determine relaxation times over a certain concentration range. They agree well with the results given by other authors. A.

539.152.2

7840. Nuclear magnetic resonance modulation correction. E. R. Andrew. Letter in *Phys. Rev.*, **91**, 425 (*July* 15, 1953).

The modulation correction for the second moment is derived, and an expression given for the $2n$th moment. It was found that the experimentally measured value of the second moment is larger than the true value by $\frac{1}{4}H_m^2$, where H_m is the modulation amplitude, and not $\frac{1}{8}H_m^2$ as given by Perlman and Bloom [Abstr. 1844 (1953)]. J. Hughes

539.152.2

7841. Dipolar broadening of the quadrupole resonance line width in zero applied field. A. Abragam and K. Kambe. *Phys. Rev.*, **91**, 894–7 (*Aug.* 15, 1953).

A formula has been derived for the contribution of the dipolar broadening to the second moment of the resonance line in pure quadrupole resonance experiments. The following assumptions have been made: The nuclear spins undergoing the resonant transitions have spin 1 or $\frac{3}{2}$. No restriction has been set on the spins of "non-resonant" nuclei contributing to the dipolar broadening. The electric field gradients at all nuclear sites have axial symmetry and common directions. A comparison is made with Van Vleck's formula for straight magnetic resonance. A.

539.153

7842. The spatial correlation of electrons in atoms and molecules. III. The influence of spin and antisymmetry on the correlation of electrons. A. Brickstock and J. A. Pople. *Phil. Mag.*, **44**, 697–704 (*July*, 1953).

For Pt II, see Abstr. 1846 (1953). This paper is concerned with the general restrictions placed on the spatial distribution of electrons by the antisymmetry principle and the specification of spin degeneracy. The total wave-function depends on the spatial and spin co-ordinates of the electrons but, if the quantum-mechanical Hamiltonian is independent of spin, it is only necessary to consider the variation of the wave-function in a subspace involving the position co-ordinates only. The restrictions on this position wave-function implied by the condition of antisymmetry and spin degeneracy of the complete wave-function are obtained. This analysis involves no approximations. Finally, the theory is used to discuss the

description of spatial correlation given by the single-determinant molecular orbital approximate wave-function and the way in which this is modified if the interelectronic repulsion is taken into account in a more refined manner. A.

539.153

7843. The spatial correlation of electrons in atoms and molecules. IV. The correlation of electrons on a spherical surface. A. BRICKSTOCK AND J. A. POPLE. *Phil. Mag.*, **44**, 705–11 (*July*, 1953).

For Pt III, see preceding abstract. The aim of this paper is to compare the effects of the exclusion principle and the interelectronic repulsion on the correlation of electrons when they are restricted to move on a spherical surface. The two examples considered are four electrons of the same spin and eight paired electrons, four of each spin. These are analogous to the ^5S state of carbon and the neon closed shell respectively. Lennard–Jones [Abstr. 6678 (1952)], using a single determinant wave-function, has shown that the correlation of electrons in these systems is such that particles with the same spin tend to arrange themselves in a tetrahedral configuration relative to one another, but that in the closed shell there is no correlation between the two tetrahedra. In this paper a more accurate wave-function is used, making some allowance for the correlation of electrons due to electrostatic repulsion. It is found that the probability of electrons of the same spin having a tetrahedral distribution is increased while at the same time there is a tendency for electrons of opposite spin to keep apart. The magnitude of this correlation between positions of electrons with opposite spin, however, is much smaller than that between those of the same spin due directly to the exclusion principle. A.

539.153

7844. Theory of complex spectra. S. MESHKOV. *Phys. Rev.*, **91**, 871–6 (*Aug.* 15, 1953).

A method for the calculation of the energy levels of an atom in terms of the experimentally observed energy levels of ions of higher ionization is developed. This method can be applied to a system of non-equivalent electrons, as well as equivalent electrons. The notion of fractional parentage is extended to systems of non-equivalent electrons. Tables of fractional parentage coefficients are calculated for p^2s, p^3s and d^2p configurations. Application is made by a least-squares calculation of the $3d^24p$ configuration of Ti II in terms of the experimentally observed energies of the $3d^2$ and $3d4p$ configurations of Ti III. As a result, the root-mean-square deviation of the calculated values from the experimental energies is reduced to $\pm 249\ \mathrm{cm}^{-1}$. A.

539.153.1

7845. The system of the atomic radii of the metals. G. B. BOKIĬ. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 3, 459–62 (1953) *In Russian.*

A table of the atomic radii of the metallic elements as observed in the metallic state, recalculated from recent data, is given. For 7 elements the new values differ by 0·03 Å or more, for 7 by 0·02 Å and for 14 by 0·01 Å from the usual values. The new radii tend to be lower for the alkali metals and higher for group II B. Na, Rb, Cs, Ba, Cd, Hg and In are changed most. From the polymorphic metals Ti, Fe and Zr the decrease of radius on changing the co-ordination number from 12 to 8 is about 1·8%, which is less than the 3% predicted from geometrical considerations. For non-cubic structures (as U polymorphs) the radius was found from the formula $r = 0{\cdot}561\ V^{\frac{1}{3}}$, where V is the volume per atom. A. L. MACKAY

539.153.4

7846. The magnetic moment of the helium atom in the metastable triplet state. V. HUGHES, G. TUCKER, E. RHODERICK AND G. WEINREICH. *Phys. Rev.*, **91**, 828–41 (*Aug.* 15, 1953).

The atomic beam magnetic resonance method has been used to measure the ratio of the g value of the two-electron system in helium in the metastable $1s2s$, $^3S_1$ state to the g value of the one-electron system in atomic hydrogen in the ground $1s$, $^2S_{\frac{1}{2}}$ state. The metastable helium and the atomic hydrogen were alternately produced in a d.c. discharge tube. The helium beam was detected by measurement of the current of electrons ejected when the metastable atoms strike a wolfram wire. The hydrogen beam was detected by a Pirani gauge. The resonance frequencies for the transitions $m = \pm 1 \leftrightarrow 0$ of helium and $F, m = 1, 0 \leftrightarrow 1, -1$ of hydrogen were measured in the same magnetic field. Field values near 520 and 567 gauss were used. By the use of the Breit–Rabi formula for the hydrogen transition frequency, these measurements may be combined with experimental values for $g_p/g_J(\mathrm{H}, {}^2S_{\frac{1}{2}})$ and $\Delta\nu$ (hydrogen) to give the result $g_J(\mathrm{He}, {}^3S_1)/g_J(\mathrm{H}, {}^2S_{\frac{1}{2}}) = 1 - (11 \pm 16)\times 10^{-6}$. This result may be combined with the experimental value $g_J(\mathrm{H}, {}^2S_{\frac{1}{2}})_{\mathrm{exp}} = 2(1{\cdot}001128 \pm 12\times 10^{-6})$ to give $g_J(\mathrm{He}, {}^3S_1) = 2(1{\cdot}001117 \pm 20\times 10^{-6})$ or with the theoretical value $g_J(\mathrm{H}, {}^2S_{\frac{1}{2}})_{\mathrm{theoret}} = 2(1{\cdot}0011276)$ to give $g_J(\mathrm{He}, {}^3S_1) = 2(1{\cdot}001117 \pm 16\times 10^{-6})$. These results are in good agreement with the theoretical values, $[g_J(\mathrm{He}, {}^3S_1)/g_J(\mathrm{H}, {}^2S_{\frac{1}{2}})]_{\mathrm{theoret}} = 1 - 23\times 10^{-6}$ and $g_J(\mathrm{He}, {}^3S_1)_{\mathrm{theoret}} = 2(1{\cdot}001104)$, calculated to order α^2 by Perl and Hughes in the accompanying paper (abstract following). This agreement tends to substantiate the arithmetic additivity of the anomalous magnetic moments of the two electrons and the non-radiative relativistic bound-state correction to the magnetic moment for the two electrons in helium. The mutual radiative correction arising from the Breit interaction is small compared with the experimental uncertainty. A.

539.153.4

7847. Relativistic contributions to the magnetic moment of $^3S_1$ helium. W. PERL AND V. HUGHES. *Phys. Rev.*, **91**, 842–52 (*Aug.* 15, 1953).

These are of order $\alpha^2 \sim (137)^{-2}$ in the lowest energy triplet state $^3S_1$, and arise from the effect of the electrostatic and Breit interactions in a relativistic wave equation. The purpose of the calculation was to isolate to order α^2 the quantum electrodynamic radiative contributions to the magnetic moment of a bound two-electron system for comparison with experiment. The method of calculation was to evaluate the sixteen-component form of the matrix element of magnetic interaction energy in terms of non-relativistic wave-functions in Pauli approximation and to use the angular and spin symmetry properties of the $^3S_1$ state. This procedure was possible because

Russell–Saunders coupling in the Pauli approximation could be shown to hold rigorously to order α^2. The result derived was that the g-value for two interacting electrons bound in a $^3S_1$ state is $2(1-\frac{1}{3}\langle T\rangle-\frac{1}{6}\langle e^2/r_{12}\rangle)$ where $\langle T\rangle$ is the expectation value of total kinetic energy and $\langle e^2/r_{12}\rangle$ of electrostatic interaction in the $^3S_1$ state, in units mc^2. The contribution $-\frac{1}{3}\langle T\rangle$ corresponds to the Breit–Margenau result for one electron and $-\frac{1}{6}\langle e^2/r_{12}\rangle$ arises from the Breit interaction. For $^3S_1$ helium the preceding g-value was evaluated numerically as $2[1-(38\cdot7+2\cdot3)\times10^{-6}]$. Comparison of theory and experiment tends to substantiate the non-radiative contribution $-\frac{1}{3}\langle T\rangle$ and the additivity properties of radiative and non-radiative contributions to the magnetic moment of $^3S_1$ helium. The fourth-order radiative contribution is not contradicted. The Breit interaction contribution is too small to be noticed, with the present experimental error. See also preceding abstract. A.

539.153.4

7848. Relativistic contributions to the magnetic moment of n-electron atoms. W. PERL. *Phys. Rev.*, **91**, 852–8 (*Aug.* 15, 1953).

A Schrödinger–Pauli approximation wave equation for an n-electron atom in an external magnetic field H is derived from a Dirac equation by straightforward extension of the procedure for $n=2$. The order α^2 terms in the resulting Hamiltonian contain corresponding $\alpha^2\mu_0 H$ and α^2Ry (fine structure) parts. The $\alpha^2\mu_0 H$ terms can be arranged as a sum of the existing relativistic bound state contributions due to Breit, Margenau and Lamb, and an additional contribution. The additional contribution is analogous to the spin-orbit contribution to fine structure. In the $^2S_{\frac{1}{2}}$ ground state of the heavier alkalis it is estimated to yield a positive contribution to the atomic g-value of the order of ten times the aforementioned (negative) contributions, which may help to account for some experimental results. A.

539.153.4

7849. Electrostatic energy matrices of the configuration f^4. E. F. REILLY. *Phys. Rev.*, **91**, 876–8 (*Aug.* 15, 1953).

The matrices are computed by the Racah method, which separates terms of the same kind. The diagonal sums of these matrices are checked by the Slater diagonal sum rule. Three of the matrices are checked by a method developed by Innes. A.

539.153.4 : 530.145

7850. A generalized self-consistent field method. J. C. SLATER. *Phys. Rev.*, **91**, 528–31 (*Aug.* 1, 1953).

A self-consistent field method is set up, general enough to be used in the case of configuration interaction between any number of states each represented by a single determinantal wave-function. Thus it is more general than the Hartree–Fock method, which is limited to a single determinantal wave-function. A variation method cannot be used, for if a sufficiently extensive configuration interaction is carried out, an equally good final value of the energy and wave-function will be obtained irrespective of the one-electron functions used. Instead the original postulate of Hartree is returned to, that each electron is assumed to move in the averaged charge distribution of all other electrons, and all nuclei. It is shown that when this condition is properly interpreted, it leads to a unique potential for the self-consistent field, all the one-electron orbitals being solutions of the same Schrödinger equation, and hence orthogonal to each other. This field is somewhat different from that of Hartree, who did not literally follow this prescription for finding the potential. For the case of a single determinantal function, the present method reduces to the simplification of the Hartree–Fock method recently proposed by the writer [Abstr. 4113 (1951)]. A.

539.154.3 : 539.133

7851. Comparison of the two principal methods of calculating atomic and molecular polarizabilities. J. TILLIEU AND J. GUY. *C.R. Acad. Sci.* [*Paris*] **236**, 2222–4 (*June* 8, 1953) *In French.*

In practice the perturbation method can only be used when the eigenfunctions of the continuous spectrum are ignored. The variation method therefore appears preferable. J. JACOBS

539.155.2

7852. Some aspects of isotope enrichment by means of high speed centrifuges. H. KLEPP. *JENER Rep.*, *No.* 12, 13 *pp.* (1953).

The yields under batch and under continuous operation are compared. Numerical data for the enrichment of U^{235}, as UF_6, are given. R. H. DAVIES

539.155.2

7853. Isotope enrichment by migration in a solid subjected to an electric field. M. CHEMLA AND P. SUE. *C.R. Acad. Sci.* [*Paris*] **236**, 2397–9 (*June* 22, 1953) *In French.*

A mixture of isotopes diffusing into a solid becomes relatively richer in the more rapidly diffusing isotope the greater the distance from the surface: the enrichment is greater at a given distance if the diffusion occurs in the presence of an electric field. Experiments with a mixture of Na^{22} and Na^{24} diffusing into NaCl or KCl for 20 hours at about 750°c in a field of 33 V/cm showed a 10–20% enrichment of Na^{22} at the distance of maximum penetration ($\sim$ 1 mm). A. D. LE CLAIRE

539.155.2 : 542.48

7854. Fractionation of isotopes by distillation of some organic substances. P. BAERTSCHI, W. KUHN AND H. KUHN. Letter in *Nature* [*London*] **171**, 1018–20 (*June* 6, 1953).

Describes experiments on carbon tetrachloride, chloroform, methyl alcohol and benzene. It was found that there is an enrichment of carbon-13 in the distillate, whereas the other heavy isotopes such as chlorine-37 and oxygen-18 are enriched in the still pot. L. G. CARPENTER

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16

7855. Radioactivity of Etna lava. S. M. TAMBURINO AND A. STELLA. *Nuovo Cimento*, **9**, 1044–53 (*Nov.*, 1952) *In Italian.*

Using nuclear emulsions and the techniques of thin sections and of layers of powdered and pressed rocks, the radioactivity of several Etnean lavas has been

investigated. It has been found that the radioactivity changes by a factor 1·5 for lavas emitted in various phases of the same stream and by a factor 1·75 for lavas of different streams, also if they took place thousands of years apart. One concludes, therefore, that the radioactivity of Etnean lavas does not substantially depend on the age of the stream. It has been found, further, that the radioactive elements are detected in the fundamental mass and are never included in the phenocrystals. The radioactivity of the fundamental mass of the various streams has been measured and a maximum change by a factor 1·51 has been found between lavas of different streams. The average value of the radioactivity of the fundamental mass is twice the average value of the radioactivity of the corresponding lava. It seems that at least part of the radioactive elements are associated with apatite. A.

539.16 : 541.182.3 : 614.898

7856. Properties, maximum doses and intensity measurements of aerosols with an α radioactivity. G. DELIBRIAS AND J. LABEYRIE. *J. Phys. Radium*, **14,** 407–18 (*June*, 1953) *In French.*

The formation, size distribution and effect of turbulence on such aerosols is discussed. Various methods of collecting samples to measure the radioactivity are outlined, and a particular form of filter is discussed in detail. A brief review of the available data on maximum concentrations tolerable by men is given. Two types of method of measuring the activity are discussed, autoradiography with a nuclear plate and proportional counts using either a Geiger counter or a scintillation method. It is shown that autoradiography is the more sensitive and is capable of detecting a concentration well below 1/1000th of the maximum tolerable level. J. M. HOUGH

539.16.08

7857. The analysis of angular correlation and angular distribution data. M. E. ROSE. *Phys. Rev.*, **91,** 610–15 (*Aug.* 1, 1953).

Consideration of a number of problems which arise in the analysis of angular correlation and angular distribution data is given. These include corrections for finite angular resolution. For a source of constant strength the questions of determination of most probable counting rates, their associated errors and the determination of the most probable coefficients in the Legendre representation of the data, as well as the errors in the determination of these coefficients, are examined. A brief discussion of the corrections for a decaying source is also presented. A.

539.16.08

7858. The correction for finite angular resolution in directional correlation measurements. J. S. LAWSON, JR, AND H. FRAUENFELDER. *Phys. Rev.*, **91,** 649–52 (*Aug.* 1, 1953).

The correction of a measured directional correlation function for the finite angular resolution of the radiation detectors (scintillation counters) has been investigated experimentally in the case of the Ni^{60} γ-γ cascade. The results show that the correction factors depend upon the pulse-height selection. The significance of this result for precision measurements is discussed. A.

539.163

7859. The excitation of atomic electrons in α-disintegrations. M. RIOU. *J. Phys. Radium*, **14,** 6S (*April*, 1953) *In French.*

The *K*, *L* and *M* X-rays of Pb emitted by Po^{210} (Ra*F*) are too intense to be explained by internal conversion of the 800 keV γ-ray, and are probably due to internal ionization during the emission of the α-particle; theoretical and exptl. results are compared.

A. O. STANESBY

539.163

7860. On the excitation of atomic electrons by α- and β-emission. P. BENOIST-GUEUTAL. *J. Phys. Radium*, **14,** 6S–7S (*April*, 1953) *In French.*

For β-emission, the transition is usually rapid enough for interaction between the emitted particle and the orbital electrons to be neglected; with medium and heavy atoms, the mean excitation energy of the atom is $\sim 22 \cdot 85 Z^{2/5}$ eV. For α-emission, the process is adiabatic, and the theoretical results agree well with experiment. A. O. STANESBY

539.163

7861. Average charge on the daughter atoms produced in the decay of A^{37} and Xe^{131m}. M. L. PERLMAN AND J. A. MISKEL. *Phys. Rev.*, **91,** 899–902 (*Aug.* 15, 1953).

The average charges on the Cl^{37} and Xe^{131} atoms produced in the transitions $A^{37} \rightarrow Cl^{37}$ and $Xe^{131m} \rightarrow Xe^{131}$ are found to be $+3 \cdot 41 \pm 0 \cdot 14$ and $+8 \cdot 5 \pm 0 \cdot 3$ electron charges, respectively. Estimates of the values to be expected from fluorescent and Auger processes and from *Z* change are made. A.

539.163

7862. The breakup energy of Be^8. K. W. JONES, D. J. DONAHUE, M. T. MCELLISTREM, R. A. DOUGLAS AND H. T. RICHARDS. *Phys. Rev.*, **91,** 879–82 (*Aug.* 15, 1953).

The $B^{11}(p, \alpha)Be^8$ reaction has been used as a source of Be^8 for the measurement of the *Q* for $Be^8 \rightarrow 2\alpha$. Protons of several MeV energy were used to bombard various thin boron targets and the break-up α's were observed at $\sim 135°$ to the proton beam. A spherical electrostatic analyser was used for measurement of the α-energy. A value of $94 \cdot 5 \pm 1 \cdot 4$ keV was found for the break-up energy. A.

539.163

7863. The breakup energy of Be^8. S. K. ALLISON. *Phys. Rev.*, **91,** 882 (*Aug.* 15, 1953).

Re-examination of the energy spectrum of the scattered protons and the disintegration particles from beryllium under bombardment with protons of approximately 400 keV energy has shown that a particle group previously thought to be the break-up α-particles from Be^8 was in fact a low-energy group of scattered protons from the impact and break-up of unfocused H_3^+ on the target. A value of the break-up energy of Be^8 (77·5 keV) based on this mistaken identification is withdrawn. A.

539.163.1

7864. The problem of the stability of technetium. E. SEGRÈ. *Nuovo Cimento*, **9,** 1008–11 (*Oct.*, 1952).

Discussion, based on nuclear, geochemical and astronomical data, on the possible existence of

isotopes of technetium with a period longer than 10^9 years. The only possible isotopes are Tc^{97} and Tc^{98} which, although radioactive, might have very long periods. A.

539.163.2

7865. Decay of ^{67}Cu and the nuclear levels in ^{67}Zn. R. H. Nussbaum, A. H. Wapstra and N. F. Verster. Letter in *Physica*, **19**, 131–4 (*Jan.–Feb.*, 1953).

The experimental results decide in favour of one of two previously proposed level schemes for Zn^{67}. J. M. CASSELS

539.163.2

7866. The nuclear levels of ^{48}Ti. M. J. Sterk, A. H. Wapstra and R. E. W. Kropveld. Letter in *Physica*, **19**, 135–7 (*Jan.–Feb.*, 1953).

The γ-rays emitted in the decay of Sc^{48} and V^{48} have been studied with a scintillation spectrometer, and a level scheme for Ti^{48} is proposed. J. M. CASSELS

539.163.2

7867. Some radioactive isotopes of I, Xe, and Cs. A. H. Wapstra, N. F. Verster and M. Boelhouwer. Letter in *Physica*, **19**, 138–9 (*Jan.–Feb.*, 1953).

The γ-rays were studied with a scintillation spectrometer. J. M. CASSELS

539.163.2

7868. Radiations from ^{142}lanthanum. A. Vanden Bosch. Letter in *Physica*, **19**, 374 (*April*, 1953).

The β-ray spectrum is complex, with a maximum energy greater than 2·5 MeV. Two γ-rays were found, with energies of 630 and 870 keV and relative intensities of about 10 : 1. J. M. CASSELS

539.163.2

7869. Radiations of neutron-deficient barium and cesium nuclides. R. W. Fink and E. O. Wiig. Letter in *Phys. Rev.*, **91**, 194 (*July* 1, 1953).

Ba^{128}, Ba^{129} and Cs^{128} produced in spallation reactions of caesium with high-energy protons. Ba^{128} is a positron emitter, maximum energy $1{\cdot}6 \pm 0{\cdot}2$ MeV. From a study of the Ba^{128}–Cs^{128} equilibrium mixture, a $1{\cdot}1 \pm 0{\cdot}7$ MeV positron group as well as the known 3 MeV group was found. No positron-γ coincidences were found for the latter group. From lead absorption measurements no γ-rays with energies $>0{\cdot}9$ MeV exist. There were conversion electrons of 0·2 MeV, and the number of positrons exceeds the number of electrons by a factor of 3 or 4. Ba^{128} decays primarily by electron capture. The following γ-rays were found: 30 keV (K X-ray), 135 ± 5 (strong), 285 ± 10 keV, 455 ± 5 keV and 965 ± 20 keV (weak). J. HUGHES

539.163.2

7870. The decay of Re^{188} and the lifetimes of Os^{186m} and Os^{188m}. C. C. McMullen and M. W. Johns. Letter in *Phys. Rev.*, **91**, 418 (*July* 15, 1953).

The γ-radiation of Re^{188} was examined using a lead radiator and double-focusing β-spectrometer and the energies and relative intensities of 8 lines are given; delayed coincidence measurements showed that the $\frac{1}{2}$-life of the 0·155 MeV excited state of Os^{188} is $(1{\cdot}7 \pm 0{\cdot}4) \times 10^{-9}$ sec. A decay scheme for Re^{188} is presented; it accounts for all presently available data. The $\frac{1}{2}$-life of the 0·137 MeV excited state in Os^{186} was also measured as $(1{\cdot}8 \pm 0{\cdot}4) \times 10^{-9}$ sec. A. O. STANESBY

539.163.2

7871. Study of Zn^{65} by proportional counter. P. Avignon. *C.R. Acad. Sci.* [*Paris*] **237**, 157–9 (*July* 15, 1953) *In French.*

The measurements reported gave a β^+ spectrum end point $= 311 \pm 10$ keV, and an intensity ratio (total K capture)/$\beta^+ = 32{\cdot}5$. The latter result indicates $K/\beta^+ = 17{\cdot}5 \pm 2$ for the ground-state transition, in agreement with a theoretical prediction for $\Delta I = 2$, $\Delta J = 1$. J. J. WILKINS

539.163.2

7872. A study of the radioactive decay of RaD by a spherical condenser-type spectrometer. Y. Kobayashi. *J. Phys. Soc. Japan*, **8**, 440–9 (*July–Aug.*, 1953).

A spherical condenser-type electrostatic spectrometer was constructed, and the spectrum of radioactive decay of RaD was studied with it. For the internal conversion lines due to the 46·7 keV γ-ray, intensity ratios $L_1 : M : N = 1 : 0{\cdot}23 \pm 0{\cdot}02 : 0{\cdot}06 \pm 0{\cdot}01$ were obtained. In the energy region between 16 and 50 keV, no internal conversion line could be found except those due to the 46·7 keV γ-ray. Many lines were observed below 16 keV, and most of them were identified as L Auger lines of bismuth. Some of them, i.e. lines at 6·6 or 7·0, 11·0, $15 \sim 16$ keV may be internal conversion lines. The primary β-ray seems to have its maximum energy at $16 \sim 18$ keV. A tentative decay scheme was proposed to explain the result. A.

539.163.2

7873. Radiations from Rb^{86} and Rb^{86m}. R. B. Schwartz, M. L. Perlman and W. Bernstein. *Phys. Rev.*, **91**, 883–4 (*Aug.* 15, 1953).

An upper limit of 1×10^{-3} is determined for the ratio of K electron capture to negative β-emission in the decay of 19·5 day Rb^{86}. The one-minute Rb^{86} isomer is shown to decay by isomeric transition, probably $E4$ or perhaps $E3$, with the emission of 560 keV γ-rays. A.

539.163.2

7874. The radiations of U^{240} and Np^{240}. J. D. Knight, M. E. Bunker, B. Warren and J. W. Starner. *Phys. Rev.*, **91**, 889–93 (*Aug.* 15, 1953).

The β- and γ-radiations of U^{240} and Np^{240} have been examined with magnetic lens and scintillation spectrometers. U^{240} ($t_{\frac{1}{2}} = 14{\cdot}1 \pm 0{\cdot}2$ hours) emits a single β-ray group of maximum energy 0·36 MeV. No γ-rays were observed. Np^{240} ($t_{\frac{1}{2}} = 7{\cdot}3 \pm 0{\cdot}3$ minutes) emits four β-ray groups with maximum energies 2·156, 1·59, 1·26 and 0·76 MeV and relative intensities of 52, 31, 11 and 5·4%, respectively. γ-Rays having energies of 1·40, 0·90 and 0·56 MeV were observed. These data can be fitted into a simple decay scheme. On the basis of cycles involving the total decay energies of these isotopes, plus published data on α- and β-transition energies and photoneutron thresholds of related nuclides, the binding energy of the last neutron in U^{240} is calculated to be $5{\cdot}92 \pm 0{\cdot}15$ MeV, and that of the last neutron in Np^{240} to be $4{\cdot}98 \pm 0{\cdot}15$ MeV. A.

539.163.2

7875. Radioactive europium 150 and gadolinium 150. C. Mack, J. J. Neuer and M. L. Pool. *Phys. Rev.*, **91**, 903–4 (*Aug.* 15, 1953).

The enriched isotopes of samarium were bombarded with 6·7 MeV protons. A well defined 3·7 hour activity was measurable in all of the enrichments. Comparison of relative initial saturation intensities clearly indicated that the activity should be assigned to Eu^{150}. The activity is the result of negatron emission. The negatron spectrum has a maximum energy of 1·07 MeV, and is classified as a first-forbidden transition on the basis of the log (ft) value. The Eu^{150} activity enables one to place a lower limit of 10^5 years on the half-life of the α-decay which has been assigned to Gd^{150}. A.

539.163.2

7876. New nuclides produced in chlorine spallation. M. Lindner. *Phys. Rev.*, **91**, 642–4 (*Aug.* 1, 1953).

The radiation properties of the β-emitting nuclides Si^{32} and Mg^{28} are described. Si^{32} was found to have a maximum probable half-life of 710 years, emitting β-particles of $E_{max} \sim 100$ keV. Absence of γ-radiation with this nuclide is indicated. A.

539.163.2

7877. The radioactivity of Cu^{67}. H. T. Easterday. *Phys. Rev.*, **91**, 653–4 (*Aug.* 1, 1953).

The β-spectrum of Cu^{67} is found to contain three groups with maximum energies and relative intensities of 577 keV, 20%; 484 keV, 35%; 395 keV, 45%. Conversion electrons from 92 and 182 keV transitions were observed. These results and the absence of the 296 keV γ-ray indicate that the β-transitions go to the ground and first two excited states of the known Zn^{67} levels. A.

539.164

7878. A study of the fine structure of the α-radiation of ionium. G. Valladas and R. Bernas. *C.R. Acad. Sci.* [*Paris*] **236**, 2230–2 (*June* 8, 1953) *In French.*

A pulse ionization chamber was used, followed by a 20-channel pulse amplitude analyser; α-particle–internal-conversion-electron coincidence measurements were also made, using a proportional counter to detect the conversion electrons. Two new lines were found, with energies $\alpha_2 = 210 \pm 10$ (intensity $\sim 0{\cdot}12$) and $\alpha_3 = 245 \pm 15$ keV (intensity $0{\cdot}03 \pm 0{\cdot}015$ quanta/100 disintegrations of ionium) below the main α-particle group. A. O. Stanesby

539.164 : 539.166

7879. Angular correlation α–γ in the transition AcC to AcC″. Upper limit of the mean life of the first excited state of AcC″. S. Gorodetzky, A. Gallmann, A. Knipper and R. Armbruster. *C.R. Acad. Sci.* [*Paris*] **237**, 245–7 (*July* 20, 1953) *In French.*

Precision measurements ($\pm 1{\cdot}5\%$) show isotropy in the range 90°–180°. The above lifetime was $< 1{\cdot}2 \times 10^{-9}$ sec. Resulting spin assignments: Tl^{207} ground state $\frac{1}{2}$, 1st excited $\frac{3}{2}$; Bi^{211} ground state $\frac{9}{2}$. W. J. Swiatecki

539.164

7880. Theory of alpha decay. I. J. J. Devaney. *Phys. Rev.*, **91**, 587–93 (*Aug.* 1, 1953).

A preliminary report on the application of the perturbation of boundary conditions theory of Feshbach, Weisskopf and Peaslee to the problem of the decay of a virtual state is presented. In particular, the formulae for α-decay are derived. The derivation assumed no model of the nucleus nor of nuclear forces. It contains the slope of the logarithmic derivative of the wave function v. energy as the only factor related to the nuclear structure; therefore, it includes earlier theories of α-decay as special cases. A.

539.164.92

7881. Total ionization by α-particles from polonium in argon and nitrogen. G. Bertolini, M. Bettoni and A. Bisi. *Nuovo Cimento*, **9**, 1004–7 (*Oct.*, 1952) *In Italian.*

Argon and nitrogen were purified by a calcium–magnesium filled convection current purifier. Electron collection was employed, using a fast amplifier feeding an ordinary discriminator. The average energy w per ion pair in argon and nitrogen is as follows: $w_{argon} = 28{\cdot}9 \pm 0{\cdot}6$ eV, $w_{nitrogen} = 37{\cdot}9 \pm 0{\cdot}8$ eV. Results are in good agreement with the measurements of Stetter's laboratory. A.

539.165

7882. Upper limit for a second beta-transition in ^{114}In and the position of the first excited state in ^{114}Sn. R. H. Nussbaum and R. Van Lieshout. Letter in *Physica*, **19**, 451–3 (*May*, 1953).

Coincidence measurements set a strict upper limit of 2% for the second transition. This limit can be reduced to 3×10^{-3} if the energy of the first excited state of Sn^{114} is 1·2 MeV, as suggested by the systematics of even-even nuclei. The theoretically expected transition rate is discussed. J. M. Cassels

539.165

7883. A measurement of the upper energy limits of the β^+ spectra of the mirror nuclei P^{29} and Cl^{33}. M. Nahmias and T. Yuasa. *C.R. Acad. Sci.* [*Paris*] **236**, 2399–401 (*June* 22, 1953) *In French.*

The spectra were measured using a plastic scintillator (1 : 1 : 4 : 4-tetraphenyl-1 : 3 butadiene in polystyrene), photomultiplier and proportional amplifier. Values obtained were P^{29}: $E_{max} = 3{\cdot}9 \pm 0{\cdot}2$; Cl^{33}: $4{\cdot}2 \pm 0{\cdot}2$ MeV, in good agreement with values calculated for mirror nuclei from the charge-independent theory. A. O. Stanesby

539.165

7884. The beta-ray spectra of Co^{60} and Sc^{46}. Y. Yoshizawa. *J. Phys. Soc. Japan*, **8**, 435–9 (*July–Aug.*, 1953).

The β-ray spectra of Co^{60} and Sc^{46} were studied by a semicircular β-ray spectrometer with the radius of 10 cm. The spectrum of Co^{60} agrees with that of the allowed transition of Fermi theory from the maximum energy down to about 60 keV. The spectrum of Sc^{46} also agrees with that of the allowed transition from the maximum energy down to 120 keV. For Co^{60} the upward deviation which occurs at energy less than 60 keV may be due to the effect of the source thickness, but for Sc^{46} the upward deviation at energy less than 120 keV could not be completely explained. The maximum energies of Co^{60} and Sc^{46} β-rays are 316 ± 3 keV and 357 ± 3 keV, respectively. A.

539.165

7885. Experimental evidence for the Fermi interaction in the β decay of O^{14} and C^{10}. R. SHERR AND J. B. GERHART. *Phys. Rev.*, **91**, 909–14 (*Aug.* 15, 1953).

The γ-ray spectra of O^{14} and C^{10} have been investigated with a NaI scintillation spectrometer. A value of $2{\cdot}30 \pm 0{\cdot}03$ MeV was found for the O^{14} nuclear γ-ray. C^{10} has two γ-rays with energies 723 ± 15 and 1033 ± 30 keV; the number of quanta per disintegration are $0{\cdot}99 \pm 0{\cdot}08$ and $1{\cdot}65 \pm 0{\cdot}20 \times 10^{-2}$, respectively. The 1033 keV γ-ray is associated with a weak positron transition to the 1·74 MeV level in B^{10}. There are less than 10^{-8} transitions per disintegration to the 2·15 MeV level of B^{10}. By combining these results with those of heavy particle reactions and using the predictions of the charge multiplet theory on the energies of the analogue states, it is concluded that the O^{14} decay and the weak C^{10} branch to the 1·74 MeV level of B^{10} are allowed favoured $0 \rightarrow 0$ (no) transitions. From the C^{10} data it is found that the ratio of the Fermi to the Gamow–Teller interactions constants (G_F^2/G_{GT}^2) is $0{\cdot}79^{+0{\cdot}27}_{-0{\cdot}13}$, if one assumes L–S coupling, and $0{\cdot}44^{+0{\cdot}15}_{-0{\cdot}07}$ for j–j coupling. A.

539.165 : 537.542

7886. A liquid argon ionization chamber measurement of the shape of the beta-ray spectrum of K^{40}. J. H. MARSHALL. *Phys. Rev.*, **91**, 905–9 (*Aug.* 15, 1953).

A liquid argon ionization chamber has been used to compare the shape of the β-ray spectrum of K^{40} with those of Y^{91} and P^{32}. The K^{40} spectrum is found to be consistent with the shape factor $D_2 = p^6 + 7p^4q^2 + 7p^2q^4 + q^6$, in agreement with recent measurements. A.

539.165 : 539.166

7887. The beta-gamma angular correlation of ^{76}arsenic. H. ROSE. *Phil. Mag.*, **44**, 739–41 (*July*, 1953).

The β–γ angular correlation of As^{76} has been measured at specific β-ray energies using a thin magnetic lens β-ray spectrometer. The experimental results cannot be explained by a single nuclear matrix element if the γ-ray is considered as electric quadrupole radiation, but if the γ-ray is assumed to be magnetic dipole radiation good agreement with the theoretical predictions is obtained for either the first forbidden matrix element $\int \boldsymbol{\sigma} \times \mathbf{r}$ of the axial vector interaction alone or the corresponding $\int \beta \boldsymbol{\sigma} \times \mathbf{r}$ of the tensor interaction alone. A.

539.165.2

7888. The nucleon isobar as an intermediate state in the beta-process. YA. B. ZEL'DOVICH. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 1, 33–6 (1953) *In Russian.*

By writing β-decay as $N = L + \tilde{\nu}$, $L = P + e^-$ and $N = K + e^-$, $K = P + \tilde{\nu}$, where L, K are neutral and charged isobars one obtains automatically a mixture of the selection rules $\Delta J = 0$ (0–0 allowed) and $\Delta J = 0, \pm 1$ (0–0 forbidden), which, in a scheme $N = P +$ boson, boson $= e^- + \tilde{\nu}$, would require two different bosons. The coupling constants and the resulting lifetimes of the isobars are estimated ($\tau \leqslant 3 \times 10^{-18}$ sec). The isobars would show up as a resonance of some millibarns cross-section an ~100 eV width in the scattering of electrons protons. W. J. SWIATEC

539.1

7889. γ-Ray spectrum from Cs^{134}. K. GROMOV AN B. DZHELEPOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 299–300 (1952) *In Russian.*

This was analysed by making a magnetic analysis with a γ-ray spectrometer, of the conversion electron ejected from a 50 μ cellophane film, a method co siderably more accurate than those based on phot electrons or electron yields. Strong lines we obtained at 0·585 and 0·788 MeV, and very wea ones at ~1000, 1150 and 1348 MeV; the tot intensity of the 0·585 line is ~ the same as the su of the 0·561, 0·566 and 0·600 lines obtained Elliott and Bell (1947). R. C. MURRA

539.1

7890. γ-Ray spectrum of Br^{82}. B. DZHELEPOV AN A. SILANT'EV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 533–5 (1952) *In Russian.*

The spectrum obtained by magnetic analysis electrons ejected, by the γ-rays from bromobenzen containing Br^{82}, from a 50 μ thick cellophane film contained 6 lines with the following energies (keV relative intensities and half-lives: (1) 535–3·68–33 hr (2) 602 keV (ill-defined); (3) 750–3·53–34 hr (4) 1020–1·00–30 hr; (5) 1292–0·85–31 hr; (6) 1445 0·40–31 hr. The last has not previously been ob served, but its half-life indicates that it belongs to th main sequence and does not arise from an impurity The highly accurate intensity measurements confu the claim by Roberts *et al.* (1941) that Nos. (1), (and (5), which they observed, form a cascade. R. C. MURRA

539.16

7891. Capture γ-rays from the $Li^7(p, \gamma)$ reaction the 440-keV resonance. E. W. TITTERTON. *Austra J. Sci.*, **15**, 174–5 (*April*, 1953).

Observations of $Li^7(\gamma, t)$ photodisintegration stan produced by the capture γ-rays are reported, an indicate a 12·5 MeV γ-ray line ~5% as intense as th 17·6 MeV line. Available evidence on the intensiti and origin of the 12·5 MeV line is discussed. J. J. WILKIN

539.16

7892. Note on some neutron capture γ-rays fro magnesium. B. B. KINSEY AND G. A. BARTHOLOMEW Letter in *Canad. J. Phys.*, **31**, 901–2 (*July*, 1953).

A new apparatus has been used to study again tw previously unresolved γ-rays, one of them being th ground state transition in Mg^{27}. Energies an intensities are given and discussed. J. M. CASSEL

539.16

7893. Determination of the period of the 27 ke electric-dipole radiation emitted in the transitio $Pa^{231} \xrightarrow{\alpha} Ac^{227}$. J. TEILLAC, M. RIOU AND P. DES NEIGES. *C.R. Acad. Sci.* [*Paris*] **237**, 41–3 (*July* 6 1953) *In French.*

α–γ delayed coincidence observations indicated period $= 4{\cdot}2 \times 10^{-8}$ sec and an L-conversion co efficient = 7. J. J. WILKIN

539.166

7894. γ–γ angular correlation measurements. S. Chatterjee and A. Kumar Saha. *Phys. Rev.*, **91**, 100 (*July* 15, 1953).

The influence of finite resolving time and angular resolution on angular correlation measurements is discussed. The effect of scattering when using unshielded detectors is briefly mentioned. J. HUGHES

539.166

7895. Gamma-gamma angular correlation in Ni^{60}. E. D. Klema and F. K. McGowan. *Phys. Rev.*, **91**, 616–18 (*Aug.*1, 1953).

The angular correlation of the γ-rays emitted in cascade from the excited states of Ni^{60} has been measured at increments of 10° from 90° to 270° with automatic apparatus using sodium iodide detectors and 5819 photomultipliers. For a dilute $CoCl_2$ source, the correlation obtained is $W(\theta) = 1 + (0{\cdot}131 \pm 0{\cdot}017)\cos^2\theta + (0{\cdot}024 \pm 0{\cdot}017)\cos^4\theta$. The anisotropy, $(\alpha_2 + \alpha_4)/\alpha_0 \equiv R$, where $W(\theta) = \alpha_0 + \alpha_2\cos^2\theta + \alpha_4\cos^4\theta$, is $0{\cdot}1557 \pm 0{\cdot}0010$. The expected value of R, taking the finite angular resolution of the apparatus into account, is 0·1517. A change in the anisotropy to a value of $0{\cdot}1453 \pm 0{\cdot}0023$ due to a chemical change in the source was observed. A.

539.166

7896. Theory of multipole radiation. J. B. French and Y. Shimamoto. *Phys. Rev.*, **91**, 898–9 (*Aug.* 15, 1953).

The connection between the exact multipole moments and their long wavelength approximations is examined. Special attention is paid to the role which the condition that the radiation source be bounded plays in this connection. Incidentally the multipole expansion is made in a very simple manner. A.

539.166 : 536.48

7897. On the "heating" resulting from the absorption of gamma-rays at extremely low temperatures. R. L. Platzman. *Phil. Mag.*, **44**, 497–500 (*May*, 1953).

The various mechanisms for the conversion of absorbed γ-ray energy to heat are surveyed. It is shown that in dielectric crystals electronic excitation of the constituent molecular groups, followed by dissociation and recombination, and ionization followed by recombination, are to a large extent responsible for the energy dissipation. The partial inhibition, at low temperatures, of the final conversion to heat is discussed, with particular reference to the γ-ray heating method in low temperature calorimetry. A.

539.166 : 539.172.13

7898. The gamma radiation from B^{11} bombarded by protons. T. Huus and R. B. Day. *Phys. Rev.*, **91**, 599–605 (*Aug.* 1, 1953).

The spectrum of γ-radiation emitted when B^{11} is bombarded by protons has been investigated with a NaI scintillation counter. Capture γ-rays have been found which occur in a direct transition to the ground state of C^{12} and a cascade transition through a level in C^{12} at 4·45 MeV. Yield curves for these γ-rays have been obtained for proton energies up to 2·8 MeV, and the cross-sections for emission of the various γ-rays are given. In addition to the well-known resonance at 0·163 MeV, new resonances have been found at 0·675 MeV with $\Gamma = 0{\cdot}33$ MeV and 1·388 MeV with $\Gamma = 1{\cdot}27$ MeV. Spin and parity assignments for these states which are deduced from the results of this and the $B^{11}(p, \alpha)Be^8$ reactions are 2^- (or 3^+) and 1^-, respectively. A 2·13 MeV γ-ray has also been observed, which is produced in an inelastic scattering reaction involving the first excited state of B^{11}. This reaction exhibits a resonance at 2·664 MeV with a width of 48 keV. The cross-section at resonance is $3{\cdot}1 \times 10^{-26}$ cm². A.

539.166 : 539.172.13

7899. The angular distribution of 12-MeV gamma rays from proton bombardment of B^{11}. G. L. Jenkins, L. W. Cochran, B. D. Kern and T. M. Hahn. *Phys. Rev.*, **91**, 915–17 (*Aug.* 15, 1953).

To investigate possible interference between the three excited states in C^{12} arising from proton bombardment of B^{11} at proton energies of 163 keV, 680 keV and 1388 keV, the angular distribution of 12 MeV γ-rays from proton bombardment of thick natural boron targets has been investigated in the energy region between 200 keV and 1100 keV. The 12 MeV γ-rays were resolved with a scintillation spectrometer. The angular distribution with respect to the proton beam was found to be of the form $Y(\theta) = 1 + A\cos\theta + B\cos^2\theta$, with A vanishing at 200 keV, reaching a value of 0·13 between 300 keV and 350 keV, and remaining approximately constant above this energy up to 1100 keV. The value of B is 0·22 at 200 keV, decreases to 0·09 at 500 keV, and remains approximately constant above this energy up to 1100 keV. A.

539.166.83

7900. Auger and conversion lines from RaD. Y. Kobayashi and G. Miyamoto. Note in *J. Phys. Soc. Japan*, **8**, 273–4 (*March–April*, 1953).

The spectrum has been measured from 3 to 50 keV. Twelve lines were observed below 14 keV, including lines at 11 keV and 4–5 keV which may be due to 27·4 keV and 7–8 keV γ-rays. No lines were observed between 14 and 30 keV. A similar investigation of (RaE + Po) revealed no lines below 50 keV. J. J. WILKINS

539.166.83

7901. Internal conversion in the *L* subshells. J. B. Swan and R. D. Hill. Letter in *Phys. Rev.*, **91**, 424 (*July* 15, 1953).

L_I, L_{II} and L_{III} conversion coefficients (relative values) have been measured for four $E2$ transitions and for two ($M1 + E2$) transitions, with results in good agreement with the theoretical values of Gellman *et al.* [Abstr. 4587 (1952)]. J. J. WILKINS

539.166.835

7902. On the annihilation spectrum of positrons in freon and oxygen. G. M. Lewis and A. T. G. Ferguson. *Phil. Mag.*, **44**, 1011–18 (*Sept.*, 1953).

An examination of the radiation arising from the annihilation of positrons, from Na^{22}, in the gases freon and oxygen, in delayed coincidence with the nuclear 1·28 MeV γ-ray, has been made, using scintillation counters. The annihilation spectrum in freon, so obtained, has been compared with the

theoretical three-quantum continuous spectrum of Abstr. 4971 (1949), taking into account the characteristics of the spectrometer crystal; and the curves are substantially similar. The spectrum in oxygen, on the other hand, indicates a single γ-line at 510 keV. Some decay times have been measured. The results are discussed. A.

539.166.835

7903. Bremsstrahlung at high energies. H. A. Bethe, L. Maximon and F. Low. Letter in *Phys. Rev.*, **91**, 417 (*July* 15, 1953).

It is shown that in the calculation of Maximon and Bethe of the cross-section [Abstr. 7533 (1952)] the final state electron wave function in the matrix element should be represented as the sum of a plane wave + an ingoing spherical wave, instead of taking both initial and final wave functions as plane waves + outgoing spherical waves. A formula is given for the modified cross-section. J. HUGHES

539.166.84

7904. On the inner deceleration spectrum of ^{32}P in the low energy region. G.-A. Renard. *J. Phys. Radium*, **14**, 361–5 (*June*, 1953) *In French.*

The inner bremsstrahlung spectrum of P^{32} has been studied, by a proportional counter method, in the region 3 to 30 keV. Satisfactory agreement with theory was obtained. J. J. WILKINS

539.167.3 : 541.15

7905. Preparation of ^{76}As from cacodylic acid by the Szilard [–Chalmers] reaction. H. Laurent and P. Simonnin. *J. Phys. Radium*, **14**, 294–8 (*May*, 1953) *In French.*

Cacodylic acid [$(CH_3)_2AsOOH$] was irradiated with slow neutrons, and arsenic produced by the Szilard–Chalmers reaction co-precipated with ferric hydroxide, taken up with HCl and the ferric ion removed on an ion-exchange column. The arsenic was oxidized to arsenate, and obtained as the ammonium salt. The yield was ~40–50%, and the specific activity ~9 mC/mg As. A. O. STANESBY

539.169

7906. Preparation of a source of zinc 65 with very high specific activity. T. Yuasa. *C.R. Acad. Sci. [Paris]* **236**, 2498–9 (*June* 29, 1953) *In French.*

Details are given of the preparation of a 4 mC/mg source, by an electrolytic method, from copper irradiated by 24 MeV deuterons. J. J. WILKINS

539.169 : 537.22

The use of Tl^{204} in radioactive static eliminators. *See Abstr.* 7649

NUCLEAR REACTIONS 539.17

539.172

7907. The determination of the mass of energetic helium isotopes emitted in nuclear explosions. T. Holtebekk, N. Isachsen and S. O. Sörensen. *Phil. Mag.*, **44**, 1037–47 (*Sept.*, 1953).

The mass spectrum of energetic helium isotopes, ejected during the explosive disintegration of nuclei, is determined, and the He^3/He^4-ratio is found to be less than 0·05. The frequency of emission of energetic He^6-nuclei is probably negligible. Measurements are carried out on the ratio of single protons to deuterons at an altitude of 3500 m, and the result is found to be in accordance with previous estimates. The identification of the particles depends on a particular scattering method which is described. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 7753, 7778–85

539.172

7908. Excitation of the nucleus by the absorption of π^- mesons. I. General considerations. G. Puppi, V. de Sabbata and E. Manaresi. *Nuovo Cimento*, **9**, 726–33 (*Aug.*, 1952) *In Italian.*

Investigates the excitation of a nucleus $A = 100$ due to the capture of a π^- bound in the lowest orbit. The model used implies the absorption of the π^- by a pair of nucleons of a Fermi gas at zero temperature. The process is divided into two phases: the first practically instantaneous, takes place between the absorption act and the instant at which the two small avalanches originating from the point in which the absorption took place reach the nucleus surface; in the second the particles which were not instantaneously released heat the nucleus, which becomes de-excited through an evaporation process. Two-thirds of the total energy absorbed are instantaneously released and about one-third (52 MeV) is evaporated. The energy becoming visible in form of ionizing particles is about 40 MeV. The mean number of neutrons is ~1·75 and the spectrum is very rich at the very low energies (<10 MeV). The problem has been solved using the Monte Carlo method. A.

539.172

7909. Production of high-energy electron pairs by negative pions in nuclear collisions. M. Schein, J. Fainberg, D. M. Haskin and R. G. Glasser. *Phys. Rev.*, **91**, 973–80 (*Aug.* 15, 1953).

Nuclear plates were exposed to negative pion beams of the 450 MeV Chicago cyclotron to search for high-energy pairs produced in nuclear collisions. The seven pairs found exhibit the following characteristics: (*a*) the mass of the particles is less than 10 electron masses, so the pairs probably consist of electrons; (*b*) the energies of the pairs range from 22 to 205 MeV; (*c*) the angles between the particles of the pair range from 0·3° to 25·9°; (*d*) the distance from the star to the point of origin of the pair—"gap"—was definitely less than 2 microns (determined by reprojection); (*e*) the angle between the centre of mass of the pair and the direction of the incoming pion was 125° with a spread of ±15°. The most reasonable assumption seems that they are due to the process: $\pi^0 \rightarrow e^+ + e^- + \gamma$ first discussed by Dalitz [Abstr. 9717 (1951)]. If this explanation should hold, then from the measured gaps the lifetime must be definitely less than $4{\cdot}8 \times 10^{-15}$ sec. However, if all the seven pairs were due to the proposed decay scheme of the π^0-meson, the probability of the observed angular distribution (*e*) is certainly less than 2×10^{-5}. A possible explanation for the observed effect is that the pair may tend to line up in direction with the neutral pion direction. A.

539.172 : 539.172.4 : 778.34

7910. Neutron and meson stars induced in the light elements of the emulsion. M. BLAU, A. R. OLIVER AND J. E. SMITH. *Phys. Rev.*, **91**, 949–57 (*Aug.* 15, 1953).

Laminated emulsions have been exposed to the neutron and positive meson beam at the Nevis cyclotron. In the case of the neutron exposure (300 MeV) it has been found that 21 ± 3% of the emulsion stars originate in light nuclei. The number of fast protons and their angular distribution is similar in stars from light and heavy elements. The black tracks in light element stars show a marked forward excess. The energy range of the mesons incident on the laminated emulsions was 50–80 MeV; 24–30% of the emulsion stars originate in light nuclei. In about 15–20% of these cases, the scattered meson emerges from the nucleus. Charge exchange scattering, if present at all, amounts to less than 10% of all interactions. More than 70% of the interactions (stars) result in absorption of the incident meson. The absorption occurs chiefly in nucleon pairs. A.

539.172.13

7911. Inverse Oppenheimer–Phillips process in the $Cu^{65}(He^3, \alpha)$ reaction. D. N. KUNDU AND M. L. POOL. Letter in *Phys. Rev.*, **91**, 417 (*July* 15, 1953).

Evidence for this process is inferred from the appreciable yield of the reaction at low He^3 energies (5·4 to 9·0 MeV). A $Cu^{65}(He^3, 2n)$ yield curve is also reported. J. J. WILKINS

539.172.13

7912. Energy levels in Be^8 from the reaction $Li^6(He^3, p)Be^8$. W. E. KUNZ, C. D. MOAK AND W. M. GOOD. *Phys. Rev.*, **91**, 676 (*Aug.* 1, 1953).

The energy spectrum of protons from the breakup of B^9 following He^3 capture by Li^6 has been obtained by means of a NaI crystal spectrometer. The energy range of the spectrum which corresponds to a range of excitation in Be^8 up to 11 MeV, shows two groups of protons. Because of systematic errors known to be present, the energy determinations are preliminary. With an uncertainty of about 0·25 MeV, the energy difference between proton peaks corresponds to an energy interval in Be^8 of 2·87 MeV. A.

539.172.13

7913. Measurement of the intensity of the gamma-radiation produced by the reaction $_3Li^7(p, \gamma)_4Be^8$ with a 600 keV accelerator. R. CHASTEL. *J. Rech. Cent. Nat. Rech. Sci.*, **5**, 43–54 (*March*, 1953) *In French.*

In the measurement described, the γ-ray intensity was deduced from the β^+ activity induced in a copper disk, the $Cu^{63}(\gamma, n)Cu^{62}$ reaction cross-section being taken as 10^{-25} cm^2. Details are given of the determination of corrections for irradiation and β^+ counting geometries, source size effects, etc. Several other methods of measurement are discussed briefly. J. J. WILKINS

539.172.13

7914. Neutrons produced by high energy protons. T. C. RANDLE, J. M. CASSELS, T. G. PICKAVANCE AND A. E. TAYLOR. *Phil. Mag.*, **44**, 425–36 (*April*, 1953).

The energy spectra and yields of neutrons produced by the bombardment of beryllium, carbon, aluminium and uranium with protons of energy 160 MeV have been measured at an angle near the forward proton direction. [See also Abstr. 5743 (1951)]. A.

539.172.13

7915. Neutrons from the proton bombardment of Be^9. F. AJZENBERG AND W. W. BUECHNER. *Phys. Rev.*, **91**, 674–5 (*Aug.* 1, 1953).

Be^9 has been bombarded with 6·59 MeV protons. The resultant neutrons, studied by means of nuclear emulsions, indicate an excited state of B^9 at 2·37 ± 0·04 MeV. A continuum of neutrons has also been observed. A.

539.172.13

7916. The angular distribution of alpha particles from the proton bombardment of ^{18}O. A. V. COHEN. *Phil. Mag.*, **44**, 583–96 (*June*, 1953).

Interference effects in the angular distribution of α-particles from the reaction $O^{18}(p, \alpha)$ have been investigated over the range 430 to 890 keV proton energy. The experimental results have been fitted in terms of a series of overlapping levels. It is found that the levels in F^{19} formed by resonant capture of protons of energy 640 keV and 850 keV have spins 3/2 and 1/2 respectively, and are of opposite parity to the level which gives the main contribution to the yield away from these energies, and which has a spin of 1/2. It is a feature of this reaction that absolute parities cannot be found from the study of the angular distributions. A.

539.172.13

7917. Excitation curves for α particles from B^{11} bombarded with protons. O. BECKMAN, T. HUUS AND Č. ZUPANČIČ. *Phys. Rev.*, **91**, 606–9 (*Aug.* 1, 1953).

The spectra of the α-particles emitted from B^{11} under proton bombardment have been investigated by means of a 180° double-focusing magnetic spectrometer. In the range of bombarding energies from 0·3 MeV to 1·8 MeV, the α group leading to the first excited state of Be^8 exhibits the same resonances, at 0·67 MeV and 1·4 MeV, as does the proton capture process, whereas the α group leading to the ground state of Be^8 is resonant only for the higher energy. The approximate values for the cross-sections at the maxima are in the former case 600 millibarns and 150 millibarns, respectively, and, in the latter, 6 millibarns. Spin and parity assignments of 2^- and 1^- for the two levels, respectively, are compatible with these results. A.

539.172.13

7918. Excitation functions for proton-induced reactions with copper. J. W. MEADOWS. *Phys. Rev.*, **91**, 885–9 (*Aug.* 15, 1953).

Proton bombardment at energies up to 100 MeV have been carried out in the Harvard University cyclotron using targets of $Cu^{63}O$ and $Cu^{65}O$. Absolute cross-sections of the (p, n), $(p, 2n)$, (p, pn) and $(p, p2n)$ reactions of Cu^{63} and the $(p, 3n)$, $(p, 4n)$, (p, pn), $(p, p3n)$ and $(p, p4n)$ reactions of Cu^{65} have been determined using the $C^{12}(p, pn)C^{11}$ and $Al^{27}(p, 3pn)Na^{24}$ reactions to monitor the proton beam. An estimate of the ratio of level densities for odd-odd and even-even nuclei is made. A.

539.172.13

7919. The elastic scattering of protons by lithium. W. D. WARTERS, W. A. FOWLER AND C. C. LAURITSEN. *Phys. Rev.*, **91**, 917–21 (*Aug.* 15, 1953).

The cross-section for the reaction $Li^7(p, p)$ has been measured over the proton energy range 360–1400 keV. Measurements were made at scattering angles of 50, 70, 89·2, 110, 130, 143·4 and 160 degrees in the centre-of-mass system. Anomalous scattering was observed near 441·5 keV, the resonance energy for the reaction $Li^7(p, \gamma)$, and near 1030 keV, the resonance energy for the reaction $Li^7(p, p')$. Analysis of the results at 441·5 keV indicates a state in Be^8 with $J = 1$, even parity, formed by p wave protons. The relative stopping cross-section for protons in lithium was also measured from 200–1300 keV. A.

539.172.13 : 537.531

7920. Production of characteristic X-rays by protons of 1·7- to 3-MeV energy. H. W. LEWIS, B. E. SIMMONS AND E. MERZBACHER. *Phys. Rev.*, **91**, 943–6 (*Aug.* 15, 1953).

Characteristic X-rays produced when protons of 1·7 to 3 MeV energy are stopped in thick targets of Mo, Ag, Ta, Au and Pb have been studied using a NaI scintillator. *K*- and *L*-radiation for the three heavy elements produced well-separated differential pulse-height peaks, while only the *K*-radiation was detectable for Mo and Ag. Cross-sections for *K* ionization have been calculated, with corrections for the Auger effect, and compared with the theory. Ratios of experimental to theoretical cross-sections vary from one to four, with good agreement for the light elements and low proton energies. The measured cross-sections at 2·4 MeV proton energy are 11, 3·0, 0·036 and 0·010 barns for Mo, Ag, Ta, Au and Pb, respectively. A.

539.172.13 : 539.166

Gamma-rays from B^{11} bombarded with protons. *See Abstr.* 7898–9

539.172.13

7921. On the experimental study and the mechanism of the reaction $B^{10}(d, \alpha)2\alpha$. P. CÜER AND J.-J. JUNG. *C.R. Acad. Sci.* [*Paris*] **236**, 2401–3 (*June* 22, 1953) *In French.*

The reaction was studied at an incident deuteron energy of 1 MeV; the results confirm the classical mechanism $B^{10}(d, \alpha)Be^{8*} \rightarrow 2\alpha$, and excited states of Be^8 were found at 5 and 7·5 MeV, and probably at 4·1 and 9·6 MeV. The intensity of the immediate reaction $B^{10}(d, 3\alpha)$ is small ($\lesssim 5\%$). A. O. STANESBY

539.172.13

7922. Theory of (d, p) and (d, n) reactions. E. GERJUOY. *Phys. Rev.*, **91**, 645–9 (*Aug.* 1, 1953).

The theory of angular distributions in (d, p) and (d, n) reactions is developed by means of standard Green's function techniques, thereby yielding a straightforward derivation of a formula originally deduced by Butler. To minimize formal complications the particles are assumed spinless, and the nucleus replaced by a centre of force. It is shown that Butler's theory involves an approximation equivalent to Born approximation, which elucidates the agreement between the Butler and Born approximation derivations of the stripping formula. A discussion relating to the success of the theory is appended. A.

539.172.1

7923. The excitation function for the $Al^{27}(d, \alpha p)Na$ reaction. R. E. BATZEL, W. W. T. CRANE AND G. E. O'KELLEY. *Phys. Rev.*, **91**, 939–42 (*Aug.* 15, 1953).

The absolute cross-section for the $Al^{27}(d, \alpha p)Na$ ($T_{\frac{1}{2}} = 15·1$ hr) reaction has been measured as function of deuteron energy from the threshold t 190 MeV. Targets were irradiated on the Berkele 60 in. and 184 in. cyclotrons. The observed threshol is 11·0 ± 0·5 MeV; and the excitation function has pronounced peak of 53 millibarns at approximatel 22 MeV, falls to a broad minimum of 18 millibarn in the region of 60 MeV, and then rises slowly t 22 millibarns at 190 MeV. A.

539.172.1

7924. Some reactions induced in light nuclei b tritons. P. CÜER AND D. MAGNAC-VALETTE. *J. Phys Radium*, **14**, 15S–16S (*April*, 1953) *In French.*

The reactions were observed in lithium-loaded photographic plates. One example was found of th $Li^6(t, d)Li^7$ reaction, probably not produced by stripping process. Numerous examples of reaction giving two short-range α-tracks are probably th result of stripping collisions leading to the formation of Be^8. J. M. CASSEL

539.172.

7925. Alpha particles from the photodisintegration of silver and bromine. R. N. H. HASLAM, A. G. W CAMERON, J. A. COOKE AND E. H. CROSBY. *Canad. J. Phys.*, **30**, 349–69 (*Sept.*, 1952).

Ilford E1 nuclear emulsions were exposed behin 4 cm of lucite to the X-ray beam of the University o Saskatchewan betatron operating at energies from 12 MeV to 26·6 MeV. They were developed by "grain-gradation" process in order to suppress proton tracks and γ-ray fog. The variation in yield with energy of the double-peaked single α-particle energy spectrum resulting from the photodisintegration o silver and bromine was studied. Preliminary result are given concerning the cross-section curves corre sponding to various portions of this α-particle spectrum. The energy distributions and cross-section curves have been interpreted in terms of the statistica theory of nuclear reactions. A

539.172.

7926. The reaction $^{181}Ta(\gamma, 2n)^{179}Ta$ at 17·6 MeV and some remarks on nuclear photodisintegration. J. H. CARVER, R. D. EDGE AND D. H. WILKINSON. *Phil. Mag.*, **44**, 404–24 (*April*, 1953).

The problem of determining the variation with γ-ray energy of the total nuclear absorption cross-section is discussed with a view to testing the applicability of specific nuclear models such as that of Goldhaber and Teller for the form of the cross-section and the validity of the general account of the integrated cross-section given by Levinger and Bethe. While for light elements many competing processes must be considered, in the very heavy elements only $(\gamma, 2n)$ is a possible competitor for (γ, n) at not too high energies. The seriousness of this competition is estimated by a measurement of the ratio of the cross-sections of $Ta^{181}(\gamma, 2n)Ta^{179}$ at 17·6 MeV to $Ta^{181}(\gamma, n)Ta^{180}$ at 14·6 MeV; the result is 0·29 ± 0·11. This competition is not enough to destroy the apparent

resonance" character of the absorption. It is pointed out that the large value of $\sigma_{\gamma,n}$ at 17·6 MeV is inconsistent with the idea that a conventional compound nucleus is always formed and so the idea of purely statistical competition for the γ-ray energy should be modified in comparing neutron yields with the predictions of the dipole sum rule. The present measurements are correlated with the neutron yield curve of Halpern, Nathans and Mann. A.

539.172.3

7927. On the existence of multiple resonances in the $^{63}Ce(\gamma, n)^{62}Cu$ reaction. K. PHILLIPS. *Phil. Mag.*, **44**, 533–41 (*May*, 1953).

By the accurate control of the energy of a 20 MeV betatron it has been shown that the activation-energy curve consists of a series of small plateaux indicating the existence of narrow resonances for the photoneutron reaction in copper. A.

539.172.3

7928. Cross sections for the reaction $^7Li(\gamma T)^4He$ at 6·13, 14·8 and 17·6 MeV. E. W. TITTERTON AND T. A. BRINKLEY. Letter in *Proc. Phys. Soc.* [*London*] *A*, **66**, 579–80 (*June*, 1953).

By counting stars produced in lithium-loaded photographic plates, the cross-sections were found to be $(1·5 \pm 0·5)\times10^{-29}$ cm², $(4·9 \pm 0·8)\times10^{-28}$ cm², and $(4·7 \pm 0·8)\times10^{-28}$ cm² at 6·13, 14·8 and 17·6 MeV respectively. J. M. CASSELS

539.172.3

7929. Dipole photonuclear reactions and the independent particle model. J. L. BURKHARDT. Letter in *Phys. Rev.*, **91**, 420 (*July* 15, 1953).

A calculation of the photon-capture cross-section curve for Cu^{63}, using the independent particle model, is described and discussed. The calculated curve has the correct order of magnitude and shape, but has its maximum at about 8 MeV instead of the observed 18 MeV. J. J. WILKINS

539.172.3

7930. Photoneutron cross sections. R. MONTALBETTI, L. KATZ AND J. GOLDEMBERG. *Phys. Rev.*, **91**, 659–73 (*Aug.* 1, 1953).

The neutron yields resulting from photoneutron reactions have been measured as a function of betatron energy from threshold to 23 MeV for 22 elements. These yield curves have been analysed by the photon difference method to give the total cross-section $\sigma = (\sigma_{\gamma,n} + \sigma_{\gamma,np} + 2\sigma_{\gamma,2n})$ as a function of photon energy. Whenever possible, this cross-section has been resolved into its components using threshold considerations and subsidiary data. Some general conclusions based on the new results are presented regarding the systematics of (γ, n) reactions. A.

539.172.3

7931. Photoneutron production excitation functions to 320 MeV. L. W. JONES AND K. M. TERWILLIGER. *Phys. Rev.*, **91**, 699–707 (*Aug.* 1, 1953).

Photoneutron yields from eleven elements were obtained from bremsstrahlung of maximum energy 13·5 to 320 MeV with the reaction, $Cu^{63}(\gamma, n)Cu^{62}$, as a monitor. The yield data were analysed by a photon difference method to give the excitation functions for photoneutron production. Most of these excitation functions showed the typical resonance shape in the 20 MeV region, a low but finite "tail" to about 80 MeV and a large rise from there to 320 MeV. With the use of a calculated neutron multiplicity $\int_0^{80}\sigma dE$ for tantalum was found to be 5·1 MeV.barns, somewhat higher than $\int_0^{\infty}\sigma dE$ predicted by Levinger and Bethe for the electric dipole interaction. The rise above 80 MeV is probably due to mesonic interactions. At the meson threshold, with data for the neutron multiplicity from π^- absorption, the photon absorption cross-section was found to obey the relation, $\sigma = 0·32A^{1·3}\times10^{-28}$ cm². A.

539.172.3

7932. Photodisintegration of the deuteron at 20 MeV. J. HALPERN AND E. V. WEINSTOCK. *Phys. Rev.*, **91**, 934–9 (*Aug.* 15, 1953).

Counter techniques have been applied to a study of the proton angular distribution in the photodisintegration of the deuteron induced by bremsstrahlung photons from a betatron in the energy interval 18–22 MeV. The measured distribution is given by $A + \sin^2\theta(1 + 2\beta\cos\theta)$, with $A = 0·132 \pm 0·041$ and $\beta \simeq 0·1$. The total cross-section is also measured. A.

539.172.4

7933. Slow neutron scattering cross sections for rare earth nuclides. W. C. KOEHLER AND E. O. WOLLAN. *Phys. Rev.*, **91**, 597–9 (*Aug.* 1, 1953).

Coherent neutron scattering amplitudes and total scattering cross-sections have been determined for a number of elements and separated isotopes of the rare earth series. One nuclide, Sm^{152}, was found to scatter with negative phase. A.

539.172.4

7934. Energy dependence of neutron total cross sections. F. MANDL AND T. H. R. SKYRME. *Phil. Mag.*, **44**, 1028–36 (*Sept.*, 1953).

The observed energy dependence of neutron total cross-sections in the energy range 60 to 153 MeV is analysed in terms of single particle scattering by a complex square well potential, using a first approximation to a variational method. The observed peaks and dips in the cross-section can be explained with a reasonable choice of potential. A.

539.172.4 : 551.510.41

7935. Measurement of the (n, H^3) cross section in nitrogen and its relationship to the tritium production in the atmosphere. E. L. FIREMAN. *Phys. Rev.*, **91**, 922–6 (*Aug.* 15, 1953).

Nitrogen gas is irradiated by fast neutrons from a U^{235} fission plate and tritium is produced. The tritium is identified and counted by two different methods: (1) the gas is put into a cloud chamber where the H^3 electrons are identified by their range and counted; (2) hydrogen is separated from nitrogen by its passage through palladium and is then counted in a Geiger counter. The average cross-section for fission neutrons with energy sufficient to make the reaction proceed [4·4 MeV is $(11 \pm 2)\times10^{-27}$ cm²]. This cross-section combined with cosmic-ray neutron data gives an H^3 production rate of between 0·10/cm² sec and 0·20/cm² sec averaged over the earth. Cosmic-ray stars eject H^3 at a rate estimated between 0·30/cm² sec and 0·70/cm² sec. These two processes

maintain a world reservoir of 50 to 110 million curies of H^3. This H^3 production leads to a mean escape time of He^3 from the atmosphere of about 5 million years. This is consistent with a temperature at the base of the exosphere of 1500°K. A.

539.172.4

7936. Fission cross section of uranium-234. R. W. LAMPHERE. *Phys. Rev.*, **91**, 655–8 (*Aug.* 1, 1953).

The neutron-induced fission cross-section of U^{234} has been measured from threshold to 4 MeV neutron energy, using the $T(p, n)$ reaction with a tritium gas target, and the Oak Ridge 5 MeV Van de Graaff. The curve rises from threshold at 350 keV to 1·3 barns at 4 MeV. There is a minimum at 1·08 MeV and another at 2·30 MeV. These dips are about 13% and 7%, respectively, of the cross-section at these points. Statistics in these regions are sufficient to establish the fact that the minima are real to a probability of 10^9 relative to a "best fit" curve with no extrema. A.

539.172.4 : 539.185

7937. Long-lived delayed neutrons from fission. J. W. KUNSTADTER, J. J. FLOYD AND L. B. BORST. *Phys. Rev.*, **91**, 594–6 (*Aug.* 1, 1953).

Low-intensity delayed neutrons from uranium have been observed with half-lives of 3, 12 and 125 min and yields per fission of $5{\cdot}8\times10^{-8}$, $5{\cdot}6\times10^{-10}$ and $2{\cdot}9\times10^{-10}$ respectively. A.

539.172.4

7938. The chain ^{79}As–^{79m}Se in slow neutron fission of ^{235}U. J. G. CUNINGHAME. *Phil. Mag.*, **44**, 900–6 (*Aug.* 1953).

As^{79} and Se^{79m} have been found as slow neutron fission products of U^{235}. The half-life of As^{79} has been measured as $9{\cdot}01 \pm 0{\cdot}15$ min, its maximum β-energy as $2{\cdot}3 \pm 0{\cdot}1$ MeV and its fission yield as $(5{\cdot}3 \pm 0{\cdot}5)\times10^{-2}$%. The half-life of Se^{79m} has been measured as $3{\cdot}88 \pm 0{\cdot}06$ mm and its maximum conversion electron energy as $0{\cdot}098 \pm 0{\cdot}014$ MeV. The assignment of mass 79 to the 9 min arsenic activity is confirmed. Details of the rapid arsenic purification procedure developed, and aluminium absorption curves for As^{79}–Se^{79m} and for Se^{79m}, are given. A.

539.172.4

7939. The elements of nuclear reactor theory. S. GLASSTONE AND M. C. EDLUND. *London: Macmillan, vii + 416 pp.*

Review in *Brit. J. appl. Phys.*, **4**, 285 (*Sept.*, 1953).

539.172.4

7940. Inspection of the rods in JEEP during the period 1st–7th December, 1952. J. BRUN. *JENER Rep., No.* 14, 8 *pp.* (1952).

An optical examination of the Al canned fuel rods, after prolonged continuous operation of the reactor, revealed that the surfaces remained in a good condition, apart from marked oxidation of the Al. Slight corrosion and pitting are attributed to small heavy metal particles and small swellings in the tube walls to the oxidation of U by active impurities. Pittings and corrosions were more marked in the central region of the reactor. Anodizing of the Al tubes is recommended to reduce corrosion.

L. R. SHEPHERD

539.172

7941. Some general aspects of thermal breedin M. BOGAARDT AND M. BUSTRAAN. *JENER Rep No.* 15, 16 *pp.* (1953).

Expressions are derived for the initial conversio ratio (number of Pu^{239} atoms formed per U^{235} ato consumed) and the breeding ratio (number of Pu atoms present in the system after a given time, p U^{235} atom consumed) in a natural U thermal reacto The number of U^{238} atoms in the system is assume constant and an infinite reactor with a uniform neutr flux distribution throughout is considered. Th formation of Sm^{149} poison is taken into accoun The variation of thermal utilization factor ar reactivity with time is investigated. Graphs showir the time dependence of these factors for variou initial conversion ratios are given. The moderato is assumed to be D_2O. L. R. SHEPHER

539.172

7942. Xe^{135} poisoning of the JEEP. V. O. ERIKSE AND W. HÄLG. *JENER Rep., No.* 17, 18 *pp.* (1953

The effect of an absorber on the reactivity of reactor is considered on the basis of a one-grou perturbation method. The theory is applied to th determination of the changes in reactivity occurrin in the JEEP, due to the fission product Xe^{135}, when th neutron flux level is changed. The theoretical resul are compared with results of experimental observa tions. L. R. SHEPHER

539.172.

7943. Recent advances in reactor technology A. M. WEINBERG. *Nucleonics*, **11**, 18–20 (*May* 1953).

A brief discussion on the nuclear reactors recentl brought into action in the U.S.A. These include the experimental breeder (EBR), the homogeneou reactor experiment (HRE), the swimming poo reactor and the materials testing reactor (MTR) The HRE is a system consisting of an aqueou solution containing enriched U, which is run at sufficiently high temperature and pressure to rais steam and drive a turbine. Such a system can b run at a high fuel burning rate because heat transfe difficulties associated with heterogeneous systems ar avoided. A high negative temperature coefficient o reactivity, $\sim -10^{-3}$/°C, makes the homogeneou reactor very safe, and it can be shown that the appli cation of 1% excess reactivity can only lead to maximum temperature rise of 20°C. The MTR is heterogeneous light water-cooled and moderate enriched U reactor designed to provide high fast an thermal neutron fluxes. One consequence of th large thermal neutron flux ($>10^{14} n/cm^2/sec$) is high build-up of Xe^{135} poison following a shut-down Ten hours after shutting down from a run at high power the reactor will have lost up to 20% in reactivity L. R. SHEPHER

539.172.

7944. Heavy water in nuclear reactors. W. H McCORKLE. *Nucleonics*, **11**, 21–5 (*May*, 1953).

The nuclear properties of heavy water, relating t the slowing down of neutrons, are compared with those for light water. Precautions which must be observed in handling heavy water and in its use as a

reactor moderator and coolant are outlined. A flow sheet for the heavy water system of the Argonne CP–3′ reactor is given. L. R. SHEPHERD

539.172.4

7945. Reactor operation. J. M. HARRER. *Nucleonics*, **11**, 35–40 (*June*, 1953).

A brief review of the instrumentation and operational equipment required in nuclear reactors. L. R. SHEPHERD

539.172.4

7946. Radiation safety for a reactor. J. M. SMITH, JR. *Nucleonics*, **11**, 41–5 (*June*, 1953).

A survey of the design considerations and monitoring equipment and facilities required to ensure protection from radiation and radioactive contamination in the operation of nuclear reactors. L. R. SHEPHERD

539.172.4 : 536.24

7947. Coolants. O. J. WOODRUFF, JR, W. J. MCSHANE AND W. J. PURCELL. *Nucleonics*, **11**, 27–34 (*June*, 1953).

Nuclear properties, heat transfer coefficients, relative pumping powers and other relevant properties of a number of possible reactor coolants, including H_2O, D_2O, liquid metals, He and air, are tabulated. The basic factors involved in the design of reactor coolant circuits utilizing water, liquid metal and gases are discussed. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

7948. Mesons. A summary of experimental facts. A. M. THORNDIKE. *New York: McGraw-Hill Book Company* (1952) 242 *pp*.

Review in *Phys. Today*, **6**, 15–16 (*June*, 1953).

539.18

7949. The disintegration of μ mesons in carbon. A. A. QUARANTA AND E. PANCINI. *Nuovo Cimento*, **9**, 959–68 (*Oct.*, 1952).

Describes the study of some of the properties of μ-mesons stopped in carbon. The μ^+- and μ^--mesons have been studied separately and very precise apparent mean lifetimes in carbon of $\tau^+ = 2{\cdot}22 \pm 0{\cdot}06$ μsec and $\tau^- = 2{\cdot}18 \pm 0{\cdot}07$ μsec have been found. The data obtained from these measurements are discussed and compared with those of other workers to see if there is a possible difference in the behaviour of the positive and the negative mesons. It is concluded that there are no indications for believing that there is a real difference between the natural mean lives of the μ^+- and μ^--mesons, although one cannot exclude the eventual possibility of a divergence. It is further demonstrated that there are no indications that the energy spectra of the disintegration electrons are greatly different for the + and − mesons. A.

539.18

7950. On the production of mesons in very high energy nucleon-nucleon collisions. T. F. HOANG. *J. Phys. Radium*, **14**, 395–406 (*June*, 1953) *In French*.

A kinematical method based on the Lorentz transformation has been applied to analyse showers of mesons. The energy of the primary (20–300 BeV) and the centre-of-mass angular distribution has been deduced for 15 showers with at least 8 prongs of min. ionization and fewer than 4 grey and black prongs. A plot of the multiplicity N (up to 20 charged π's) against energy reveals 2 distinct groups of which one is more consistent with Heisenberg's and the other with Fermi's theory. The angular distributions are isotropic for $N < 10$. For $N > 10$ there is an indication of 2 opposite cones (opening angle 150°). W. J. SWIATECKI

539.18

7951. The varytrons and the new mass measurements. J. DAUDIN. *J. Phys. Radium*, **14**, 419–23 (*June*, 1953) *In French*.

A critical survey of the experiments of Alikhanyan, Alikhanov *et al.* (1946–52) on mesons of mass intermediate between a π and a proton. It is concluded that the recent experiments do indicate the existence of some τ-mesons of mass $\sim 950m$, but that the existence of particles of mass $\sim 600m$ is not established. W. J. SWIATECKI

539.18

7952. The π-nucleon scattering and the reaction: nucleon (π, 2π) nucleon. B. D'ESPAGNAT. *C.R. Acad. Sci.* [*Paris*] **237**, 26–8 (*July* 6, 1953) *In French*.

Dyson's non-covariant method for the study of the π-nucleon elastic cross-section is extended to the reaction $\pi^+ + p \rightarrow n + \pi^+ + \pi^-$ in the neighbourhood of the threshold. Goldberger's G matrix (1951) is calculated. W. J. SWIATECKI

539.18

7953. On the estimate of the form parameter of the energy spectrum of electrons from μ-meson decay. J. JOUVIN. *C.R. Acad. Sci.* [*Paris*] **237**, 153–5 (*July* 15, 1953) *In French*.

Michel's theoretical spectrum (1950) is modified to take account of statistical corrections arising when the electron energy is measured by multiple scattering. A method of estimating the form parameter p and its variance is suggested. W. J. SWIATECKI

539.18

7954. The production of positive pions by 341-MeV protons on protons. W. F. CARTWRIGHT, C. RICHMAN, M. N. WHITEHEAD AND H. A. WILCOX. *Phys. Rev.*, **91**, 677–88 (*Aug.* 1, 1953).

The production of positive pions by protons on protons has been studied at 0°, 35° and 58° to the beam of 341 MeV protons produced by the Berkeley synchrocyclotron. In the collision of two protons, two reactions are possible which lead to a π^+ meson: (1) $P + P \rightarrow \pi^+ + D$ and (2) $P + P \rightarrow \pi^+ + N + P$. The experimental results at 0° show an energy spectrum from 0 to 70 MeV which is fairly flat except for a large peak at the high-energy end. The flat portion of the spectrum can only be due to reaction (2). A comparison of the shape of the peak with the results of the phenomenological theory of Brueckner and Watson shows that the peak is due solely to reaction (1). This fact, together with a measurement of the energy of the beam and of the energy of the pions from reaction (1), gives the value $275{\cdot}1 \pm 2{\cdot}5$

electron masses for the mass of the positive pion. The angular distribution in the centre-of-mass system for reaction (1) as obtained from the data at the above three angles, is $(3{\cdot}3 \pm 1{\cdot}2)[0{\cdot}11 \pm 0{\cdot}06 + \cos^2\theta] \times 10^{-29}$ cm^2 sterad^{-1}, and the total cross-section for reaction (1) is $(1{\cdot}8 \pm 0{\cdot}6) \times 10^{-28}$ cm^2. These results have been compared with the results obtained by Durbin, Loar and Steinberger and by Clark, Roberts and Wilson on the inverse reaction, $\pi^+ + D \rightarrow P + P$. Using the theorem of detailed balancing, these experiments lead to the value zero for the spin of the positive pion with good certainty. A.

539.18

7955. The production of charged photomesons from helium. Hydrogen-helium ratios. II. M. J. Jakobson, A. G. Schulz and R. S. White. *Phys. Rev.*, **91**, 695–8 (*Aug.* 1, 1953).

A study similar to that made on hydrogen and deuterium [Pt I, Abstr. 1148 (1953)] has been made with helium. Measurements were made at the three angles of 45°, 90° and 135°. π^+-mesons were detected by scintillation counters and delayed coincidence detection. π^+- and π^--mesons were detected with Ilford C2-200 μ nuclear emulsions. The π^-/π^+ ratios are $0{\cdot}99 \pm 0{\cdot}15$, $1{\cdot}07 \pm 0{\cdot}17$ and $0{\cdot}91 \pm 0{\cdot}13$ for angles of 45°, 90° and 135° respectively. The total cross-section for π^+-meson production is $4{\cdot}8 \pm 1{\cdot}0 \times 10^{-29}$ cm^2 proton$^{-1} Q^{-1}$ for helium as compared to $10{\cdot}3 \pm 2{\cdot}1 \times 10^{-29}$ for hydrogen. This indicates that a proton in helium is about one half as effective as a free proton for the photoproduction of π^+-mesons. A comparison is made of the π^+-meson production from hydrogen, deuterium, helium and carbon. A.

539.18

7956. The mass of the V_1^0-particle. R. Armenteros, K. H. Barker, C. C. Butler, M. S. Coates and M. G. Sowerby. *Phil. Mag.*, **44**, 861–70 (*Aug.*, 1953).

Accurate measurements have been made on the decay products of 22 low-energy V_1^0-particles. It is shown that the experimental data are consistent with the decay process $V_1^0 \rightarrow p^+ + \pi^- + (42^{+3}_{-2})$ MeV, the secondary particles being emitted isotropically in the rest system of the V_1^0-particle. The corresponding mass of the V_1^0-particle is $(2195 \pm 6)m_e$. The results are compared with those obtained by other groups of workers. A.

539.18

7957. Nucleon polarization in pion proton scattering. E. Fermi. *Phys. Rev.*, **91**, 947–8 (*Aug.* 15, 1953).

The polarization of the recoiling nucleons after the scattering of a pion by a nucleon is calculated. It is found that the recoiling nucleons are polarized in a direction perpendicular to the scattering plane and that the intensity ratio for spin parallel or antiparallel to this direction in several cases is quite large. Simple formulae are given for computing the polarization as a function of the scattering angle in terms of the phase shifts. A.

539.18

7958. The scattering and absorption of π^+ mesons by aluminum. J. F. Tracy. *Phys. Rev.*, **91**, 960–71 (*Aug.* 15, 1953).

The interaction of π^+-mesons with aluminium has been studied in a magnet cloud chamber containing five $\frac{1}{8}$ in. aluminium plates. Meson energies ranged from 25 to 100 MeV. 20 stops, 34 scatters $\geqslant 30°$ and 56 stars were observed. A 1-prong star and 70 MeV electron-positron pair in coincidence was interpreted as an inelastic charge-exchange scatter. All stops are reasonably accounted for by scatters and stars hidden by the geometry. The cross-sections rise steeply with energy. The scattering (elastic plus inelastic) is very roughly isotropic except for a dip in the 60° to 90° interval. Corrected absolute cross-sections for the 25–45, 45–70 and 70–100 MeV intervals, respectively, are σ(scat), 70 ± 23, 312 ± 7[illegible] and 216 ± 82 mb; σ(star), 176 ± 34, 299 ± 62 and 332 ± 100 mb; and σ(total), 246 ± 43, 611 ± 9[illegible] and 548 ± 129 mb. Detailed results and a description of experimental procedures are given. A.

539.1

7959. The mean life of negative μ mesons stopped in iron. A. H. Benade. *Phys. Rev.*, **91**, 971–2 (*Aug.* 15, 1953).

The mean life of negative cosmic-ray μ-mesons stopping in an iron absorber has been found experimentally to be $0{\cdot}21 \pm 0{\cdot}06$ μsec. The upper limit to the mean number of neutrons produced is very roughly one per meson captured by an iron nucleus. A.

539.18 : 530.14

7960. Production of mesons and the localization of field energy. H. J. Bhabha. *Proc. Roy. Soc. A*, **219**, 293–303 (*Sept.* 22, 1953).

It is shown that the production of mesons and nucleons in very energetic nucleon-nucleon collisions depends essentially on the extent to which the observed rest mass of a nucleon is due to its meson field and the spatial distribution of the energy in this field. The production of showers of mesons and nucleons is considered, assuming that a fraction ε of the observed rest mass of the nucleon is carried by the field, this rest mass being distributed according to some arbitrary function f of distance from the centre of the nucleon. The remaining fraction of the rest mass is assumed to be concentrated in a sphere of radius ζ round the centre of the nucleon, this radius being of the order of the Compton wavelength of the nucleon or less. It is shown how the experimental study of meson-nucleon production in high-energy encounters provides a method of obtaining information on the contribution of the meson field to the rest mass of a nucleon, and the localization of this energy in the meson field. A.

539.18 : 778.3

The grain density in the tracks of 117- and 222 MeV π^- mesons in emulsions. *See Abstr.* 8170

539.18

7961. Determination of the neutron spectrum by means of boron absorption. B. Grimeland. *JENER Rep., No.* 16, 11 *pp.* (1953).

Describes a method of obtaining the energy distribution of neutrons in a nuclear reactor in the absence of a time-of-flight or crystal spectrometer. The method, which is not claimed to be very accurate, consists of measuring the neutron transmission through different thicknesses of B. It is applied to one of the two fast neutron channels at the Kjeller

reactor, a channel which faces the reactor tank. Crystals of NaI(Tl) are used as detectors and the parameters of the energy distribution curve are determined. The neutron temperature corresponding to the Maxwellian part of the distribution is found to be about 400°K. J. THEWLIS

539.185

7962. Investigation of several special shielding concretes. J. BOURGEOIS, A. ERTAUD AND J. JACQUESSON. *J. Phys. Radium*, **14**, 317–22 (*May*, 1953) *In French.*

The transmission of thermal neutrons and γ-radiation through slabs of concrete of various compositions was investigated. The slabs ($103 \times 107 \times 5$ cm) were stacked against the thermal column of the Chatillon pile. Mn foils were used to measure the thermal neutron densities at points through the concrete and the flux emerging from the outer face. The results have been analysed to give effective values for macroscopic absorption and transport cross-sections in the different specimens. The γ-radiation, arising mainly from thermal neutron capture in the graphite of the column and in a cadmium layer between the column and the slabs, was measured in an ionization chamber and an effective absorption coefficient is deduced for each sample. The specimen concretes included a normal sand and gravel aggregate and aggregates containing such materials as B_4C, borax, tourmaline and serpentine ($Mg_6(OH)_8Si_4O_{10}$—giving a high H concentration), barytes and iron. L. R. SHEPHERD

539.185.08 : 537.542

7963. Boron layer scintillation neutron detectors. E. GATTI, E. GERMAGNOLI, A. PERSANO AND E. ZIMMER. *Nuovo Cimento*, **9**, 1012–21 (*Oct.*, 1952).

Neutron detection with layers of crystalline powder mixtures of a boron compound and of a scintillator, used in connection with a photomultiplier, has been studied. Efficiency of 6% for incident thermal neutrons and almost complete insensitivity to γ and cosmic rays is reached. Detector's geometry approaches that of an infinitely thin sheet. Pulses may be shaped so as to have $< \frac{1}{2}$ μsec rise time. A.

539.185.7

7964. Effect of capture on the slowing-down length of neutrons in hydrogenous mixtures. H. C. VOLKIN. Letter in *Phys. Rev.*, **91**, 425 (*July* 15, 1953).

Fermi's theoretical expression for the slowing-down length has been generalized. J. M. CASSELS

STRUCTURE OF SOLIDS 539.2

539.2 : 539.3 : 548.1 : 519.2

7965. Matter tensors in symmetrical systems. F. G. FUMI. *Nuovo Cimento*, **9**, 739–56 (*Sept.*, 1952).

Elementary group theory is shown to provide easily the independent Cartesian orthogonal components of tensor properties in material systems of finite symmetry. The method is applied to second-, third- and fourth-order polar and axial tensors of no intrinsic symmetry in trigonal and hexagonal systems, and the final results are tabulated. A.

539.213 : 541.183

7966. Effect of the adsorbed gases on the temperature of the surface devitrification in vitreous state. P. STAHL AND H. FORESTIER. *C.R. Acad. Sci.* [*Paris*] **237**, 166–8 (*July* 15, 1953) *In French.*

Experiments with two commercial glasses (ordinary soda-lime, and a barium-lithium-borate glass), two borax-boric acid glasses, and vitreous Se, and the following gases: He, H_2, Ne, N_2, A and CO_2, have shown that (1) the temperature of devitrification depends on the nature of the adsorbed gas, and (2) it increases regularly as the absolute liquefaction temperature of the gas increases (i.e. as the % of the adsorbed gas increases). See also Abstr. 6544 (1951). F. LACHMAN

539.215 : 539.434

7967. Self-diffusion and viscous flow (sintering and creep) in compressed metal powders. YA. E. GEGUZIN, L. O. MARKON AND B. YA. PINES. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 577–80 (1952) *In Russian.*

From an expression for the change in concentration of vacant sites with pressure in a crystal lattice the formula $1/\eta = D\delta^3/KTL^2$ is obtained relating the viscosity η and the coefficient of diffusion D. L represents the linear dimension of the particle. A correction to allow for the surface tension pressure has to be made when reckoning the external pressure for calculating the viscosity. For powders with $L = 3 \times 10^{-4}$ cm D was found to be 10^{-8} cm^2/sec for Cu at 900° and 10^{-9} cm^2/sec for Fe at 1100°. From the temperature dependence of η the energy of activation of self diffusion was calculated to be 36 kcal/mol for Fe and 12 kcal/mol for Cu. A. L. MACKAY

539.217

7968. Dependence of the coefficient of diffusion on the interatomic interaction in metals and alloys. I. YA. DEKHTYAR. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 1, 49–52 (1953) *In Russian.*

For D_0 appearing in the equation of diffusion $D = D_0 e^{-E_a/RT}$ the following formula is obtained [see also Gertsriken and Dekhtyar, *Dopovidi AN URSR, No.* 5, 57 (1949); Dekhtyar, *Voprosy fiziki metallov i metallovedeniya, No.* 3, *AN URSR* (1952)]: $D_0 = (kT/h)(T/\theta)^2(\delta^2/2)[1 - \Phi(y)] \quad exp(3\alpha\chi^{-1}v_a/2R)$ where θ is the characteristic temperature, δ the average interatomic distance, $\Phi(y)$ the Gaussian error function, α the coefficient of expansion, χ^{-1} the modulus of compressibility, and v_a the volume of a gram atom. This formula gives in some cases a fair agreement with experimental data obtained by other authors. Further transformation with introduction of the melting-point value yields a logarithmic formula which can be simplified to: $\log_e D_0 = A + B(E_a/RT_m)$, where A and B are parameters, E_a the energy of activation, and T_m the melting temperature. F. LACHMAN

539.217

7969. Diffusion in metals. A. D. LE CLAIRE. *J. Iron Steel Inst.*, **174**, 229–36 (*July*, 1953).

A review is given of the principal results that have been obtained from experimental and theoretical work on diffusion in metals. From a consideration

of these results a few suggestions are made on the types of experiments most likely to further an understanding of the subject. A.

539.217 : 537.583

Diffusion of barium in an oxide-coated cathode. *See Abstr.* 7748

539.217 : 539.374

7970. The effect of plastic deformation on diffusion. N. S. Fastov. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 2, 309–12 (1952) *In Russian.*

The equation for the diffusion of one component in small concentration c into another substance is deduced. It shows that diffusion is determined both by the dependence of the atomic volume on c, and of the yield point on c; in some cases, e.g. for the diffusion of C into Fe the latter can be neglected, but it cannot in others, e.g. of Au diffusing into Ag, or Ag into monocrystalline Hg. R. C. MURRAY

539.23 : 548.5

Linear film growth in tarnishing reactions. *See Abstr.* 8049

539.231

7971. [Electron diffraction] study of grain size in thin films of gold, palladium, and gold-palladium alloy, prepared by thermal evaporation. L. Lafourcade. *C.R. Acad. Sci.* [*Paris*] **236**, 2220–1 (*June* 8, 1953) *In French.*

Grain sizes of gold films varied from 15 Å to 80 Å for film thicknesses varying from 1·5 Å to 200 Å respectively. Grain sizes of palladium, 60 : 40 and 30 : 70 gold-palladium films were about 25 Å, and independent of film thickness. R. S. PEASE

539.234

7972. Electron microscope studies of evaporated cadmium and zinc. R. S. Sennett, T. A. McLaughlan and G. D. Scott. *Canad. J. Phys.*, **30**, 370–2 (*Sept.*, 1952).

Employing a technique [see Abstr. 1349 (1951)] whereby evaporations are carried out within the specimen chamber of an electron microscope, continuous observations have been made on the formation of evaporated deposits of cadmium and zinc. The particles first seen appear suddenly, have a regular crystalline shape, and are often relatively large (200 Å). At first they remain regular while increasing in size, but later develop irregular spurs, secondary crystallites, or link together with their neighbours. This behaviour is quite different from that of silver and gold in which the aggregates appear irregular at all stages. A.

539.24 : 539.27

7973. A method of observing selected areas in electron and optical microscopes. J. F. Nankivell. *Brit. J. appl. Phys.*, **4**, 141–3 (*May*, 1953).

A technique enabling systematic observations of metallurgical features in the electron microscope is outlined. Such features of interest are suitably marked; and wet stripped plastic replicas are prepared in the normal manner. A simple apparatus, briefly described, allows one to position these replicas on electron microscope specimen grids as desired. This permits direct comparison of electron and photo micrographs of any surface detail. In addition, changes in surface detail or of a given feature depth may be followed.

539.26/.27 : 541.18

7974. Measurement of particle size of fine ferro magnetic powders. A. D. Franklin, R. Campbell and J. Weinman. *J. appl. Phys.*, **24**, 1040–5 (*Aug.* 1953).

The particle sizes of four Fe and two Fe–C powders with diameters ranging from 200 to 600 have been determined using electron microscopy X-ray line broadening and nitrogen adsorption techniques. Reasonable agreement was found between the electron microscope and the X-ray methods, while the sizes determined through nitrogen adsorption were in every case larger. A method of dispersing single-domain ferromagnetic powders for electron microscopy is described.

539.2

7975. X-ray structural analysis at great distance with a widely diverging beam. A. Z. Zhmudski. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 2, 211–1 (1953) *In Russian.*

Back reflection photographs were taken of large sheets of various metals bent into cylinders using beam divergence of 50°. With a specimen-tube distance of 50 cm exposure times were reduced to 30 sec. The utility of the arrangement is questioned in discussion following the paper. A. L. Mackay

539.2

7976. On the X-ray diffraction patterns of polymer films. C. H. Bamford and H. Tompa. *Acta cryst.* **6**, 417–24 (*May*, 1953).

Equations are derived which relate the angular spread of arcs in X-ray diagrams of oriented polymer films to the dispersion of the crystallites. A simple graphical method of measuring the dispersion is indicated, and the use of the equations in indexing reflections and in checking the self-consistency of the interpretation of the X-ray diagram is pointed out. A.

539.2

7977. Examination of surfaces by X-ray reflection. R. H. Buteux. Letter in *J. Opt. Soc. Amer.*, **43**, 61 (*July*, 1953).

A number of surfaces were examined by X-ray reflection in an attempt to find reflecting surfaces superior to those at present used in X-ray optics. All the surfaces examined gave rise to reflections showing patterns of striations and it was found that surfaces more even than those produced by polishing were not obtained. J. Thewlis

539.2

7978. Studies of continuous phase transformations with X-rays. E. Gillam and D. G. Cole. *Phil. Mag.*, **44**, 999–1010 (*Sept.*, 1953).

A method described in Abstr. 5694 (1949) has been developed to study the progress of the transformation of austenite (a) into martensite as the temperature falls below the Ms point, and (b) under isothermal conditions at temperatures below the Ms point. The martensite results do not agree entirely with an empirical formula of Cohen (1951); the isothermal results show how these transformations are changed markedly by the addition of 1 or 2% of alloying

elements. The two sets of results are combined to draw the "S-curves" below the Ms point for the steels EN24, EN26 and EN30B. A.

539.26 : 539.4.015

7979. Natural ageing of aluminium alloys. Yu. A. Bagaryatskiĭ. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 559–62 (1952) *In Russian.*

Structural modifications in Al–3% Cu–1·15% Mg and Al–4% Cu single crystals during natural ageing were investigated by X-ray diffraction and are compared with changes occurring during artificial ageing at 170 and 218°c.

NUCLEAR SCIENCE ABSTRACTS

539.26 : 541.135.5

7980. An X-ray investigation of the structure of friable cathode deposits of metals. V. P. Chalyĭ. *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **17**, *No.* 2, 195–205 (1953) *In Russian.*

Back-reflection X-ray photographs were taken from metal layers as they were being deposited electrolytically. The beams passed into and out of the cell through a thin foil window and traversed a few millimetres of solution. Photographs were taken during the deposition of Zn, Cu, Ni and Fe under various conditions of temperature, concentration and cathode composition. No changes of lattice parameters were found, indicating that hydrides were not formed. The freedom from oxides and hydroxides of the cathode layer depended strongly on the oxidizing power of the anions present. No basis exists for believing that at the moment of discharge complex ions are incorporated into the lattice and cause the friability. The friability of Ni layers is not caused by a transiton to the α-form. Friability seems to be due to the disturbance of the contact between nuclei and crystals growing on them by the formation of hydrogen. A. L. MACKAY

539.27

7981. On damage to specimens by shadowing bombardment. I. Experiment. II. Calculation. K. Tokuyasu. Letters in *J. appl. Phys.*, **24**, 953–4 (*July*, 1953).

The damage is due to the impact of the shadowing atoms, which appears to denature the surface layer of organic specimens. R. S. PEASE

539.27

7982. Contour lines on the shadowed side in the electron microscope. K. Tokuyasu. *J. appl. Phys.*, **24**, 956 (*July*, 1953).

The difference between the Fresnel diffraction lines on the shadowed and unshadowed side of a polystyrene sphere [Abstr. 7532 (1950)] is not one of position but of definition. The diffraction lines appear more vague on the shadowed side, probably because of the larger scattering power of the shadowed supporting film. R. S. PEASE

539.27

7983. A replica technique in the study of chemical precipitation processes. R. B. Fischer and J. P. Ellinger. *J. appl. Phys.*, **24**, 1051–3 (*Aug.*, 1953).

A replica technique has been developed for the electron microscope study of particles of precipitates formed by mixing solutions of chemical reagents. The replica is formed thermally in a thin film of parlodion. A one-step, shadowed replica has been found most satisfactory. The technique has been found suitable for studies of the effect of conditions of observation upon the specimen materials, studies of precipitates such as silver chloride which are known to be unstable during direct observation, studies of precipitates as they exist in the mother liquid; and studies which require detailed observation of surfaces. A.

539.27 : 552.121

7984. Electron microscope photographs of polished mineral surfaces. J. Kenyon. Letter in *Nature* [*London*] **172**, 114–15 (*July* 18, 1953).

Examples are given of opaque polished mineralogical surfaces, revealing mineralogical structures and textures, the complex problems of ore deposition, and the nature of ore-forming fluids. Four photographs are reproduced taken with an electromagnetic transmission type of electron microscope and details are given of the structure and other facts displayed.

R. S. READ

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32

7985. The role of preferred orientation in elasticity investigations. G. Bradfield and H. Pursey. *Phil. Mag.*, **44**, 437–43 (*April*, 1953).

The purpose of the paper is firstly to investigate the role of preferred orientation in the elastic properties of polycrystalline metals, and secondly to apply these considerations to some experimental results. The analysis is confined to metals in the cubic crystalline system constituted so that the preferred orientation has circular symmetry about the axis of a bar, expressions being derived for the apparent elastic constants of the bar in terms of the single crystal constants and an anisotropy index. The experimental results used for illustration relate to alloys of copper with members of the first long period and cover variations in the annealing processes used. A.

539.32

7986. Anomaly in the rigidity modulus of copper alloys for small concentrations. J. Friedel. *Phil. Mag.*, **44**, 444–8 (*April*, 1953).

In the theory of work hardening, Mott [Abstr. 1991 (1953)] assumes that face-centred cubic crystals usually contain, prior to deformation, a network of dislocations, as suggested first by Frank [Abstr. 673 (1951)]; and he computes the decrease in the modulus of rigidity due to the existence of such a network. His computation may be extended to solid solutions, if one assumes the dislocations to be "pinned down" by the solute atoms. Thus the addition of solute atoms will always at first increase the shear modulus, though larger concentrations may lead to a decrease. An anomaly of the type predicted has actually been observed [Abstr. 7985 (1953)] for small concentrations in copper alloys. An average length of about

10^{-5} cm for the dislocations of the network can be deduced; and the small value of the anomaly for pure copper perhaps indicates that a large fraction of the dislocations are sessile. The anomaly has also been observed for silver alloys. It disappears after long annealing at 650°C, probably by formation of loose Cottrell clouds. A.

539.32

7987. The effect of small amounts of cold-work on Young's modulus of copper. A. D. N. SMITH. *Phil. Mag.*, **44**, 453–66 (*May*, 1953).

The effect on Young's modulus of copper of small amounts of plastic extension (1–8%) and subsequent low temperature annealing (50–100°C) has been studied. The results confirm previous work that there is a reduction of about 11% in the modulus, the greater part of which is recoverable after prolonged annealing at 100°C. The reduction is attributed to the elastic oscillation of the relatively mobile screw components of dislocation loops, recovery being caused by the annihilation of such components in pairs by cross-slip, as suggested by Mott [Abstr. 1991 (1953)]. In an analysis of the recovery process it is assumed that the activation energy required to move the two screw components together is not unique but is distributed in a Gaussian manner about a mean. This mean value is found to be 25 000 cal/mole for O.F.H.C. copper extended by 1% and 21 500 cal/mole for the same material extended by 8·4%. A.

539.32

7988. The variation of the elastic constants of crystalline aluminum with temperature between 63°K and 773°K. P. M. SUTTON. *Phys. Rev.*, **91**, 816–21 (*Aug.* 15, 1953).

The composite piezoelectric oscillator is employed to measure the adiabatic elastic moduli of crystalline aluminium over the temperature interval 63°K to 773°K. The data permit a valid extrapolation to 0°K. The Debye characteristic temperature of aluminium at 0°K, computed with these data, is 439°K. Various novel procedures designed to facilitate the use of the method are described. A.

539.32 : 534.23

7989. Measurement of elastic constants at low temperatures by means of ultrasonic waves—data for silicon and germanium single crystals, and for fused silica. H. J. MCSKIMIN. *J. appl. Phys.*, **24**, 988–97 (*Aug.*, 1953).

Ultrasonic waves (shear or longitudinal) in the 10–30 Mc/s range are transmitted down a fused silica rod, through a polystyrene or silicone one-quarter wavelength seal, and into the solid specimen. Measurement of reflections within the specimen yields values for velocities of propagation and elastic constants. Data obtained over a temperature range of 78°K for silicon and germanium single crystals, and 1·6° to 300°K for fused silica are listed. For the latter, a high loss is noted, with an indicated maximum near 30°K. A.

539.32 : 548.0

7990. "Third-order" elastic coefficients. R. F. S. HEARMON. *Acta cryst.*, **6**, 331–40 (*April*, 1953).

The definition of third-order elastic constants, and some of the properties of the associated tensors, a discussed. A direct enumeration of the third-orc constants is made for all crystal classes, and for t isotropic system; estimates are given of the numeric values of certain combinations of third-order constan for five cubic materials.

539.32 : 548

7991. Determination of the seven dynamic elas constants of ammonium dihydrogen phosphate. Y. CORRE. *C.R. Acad. Sci.* [*Paris*] **236**, 1903–4 (*May* 1953) *In French.*

Two optical methods were used to study t propagation of elastic waves in crystals of NH_4H_2PO The measurements can only be accounted for terms of, and provide the seven constants requir by, Laval's theory of elasticity [Abstr. 7313 (1951 $\pi_{12,12} = 5{\cdot}995 \pm 0{\cdot}005$; $\pi_{11,11} = 61{\cdot}05 \pm 0{\cdot}1$ $(\pi_{11,22} + \pi_{12,21}) = 17{\cdot}9 \pm 0{\cdot}3$; $\pi_{33,33} = 28{\cdot}6 \pm 1{\cdot}$ $\pi_{13,13} = 10{\cdot}3 \pm 0{\cdot}6$; $\pi_{31,31} = 7{\cdot}6 \pm 0{\cdot}5$ a $(\pi_{11,33} + \pi_{13,31}) = 24{\cdot}6 \pm 1{\cdot}8 - \times 10^{10}$ dynes/cm Voigt's theory, involving only 6 constants, requir that $\pi_{13,13} = \pi_{31,31}$. A. D. LE CLAI

539.3

7992. A note on the Portevin–Le Chatelier effe A. H. COTTRELL. *Phil. Mag.*, **44**, 829–32 (*Aug.*, 195

Substitutional solute atoms in aluminium usua diffuse too slowly to cause appreciable strain agei at room temperature. However, if the concentrati of vacancies is increased by plastic deformation or quenching, the rate of diffusion may increase su ciently to cause strain ageing during plastic deform tion. A serrated stress-strain curve should th result. These ideas are used to explain the Portevi Le Chatelier effect.

539.374 : 532.

On the relation between dynamic viscosity and rigidit *See Abstr.* 7482

539.4.011.

7993. Yield points in brass crystals. G. ARDLEY AND A. H. COTTRELL. *Proc. Roy. Soc.* **219**, 328–41 (*Sept.* 22, 1953).

A study has been made of the yielding behavio of single crystals of brass grown in either argon nitrogen. Crystals of β-brass showed sharp yie points when grown in nitrogen, but not otherwis In all β-brass crystals, plastic flow occurred jerkil each jerk being accompanied by the formation of group of slip bands, and the yield strength showed maximum at 200°C. Crystals of α-brass show yield points at room temperature when they contain 1% zinc or more, and repeated yielding at 200 when they contained 10% zinc or more, irrespecti of whether they were grown in argon or nitroge these yield points are considered to be caused by t segregation of zinc atoms to dislocations, and theoretical estimate is made of the critical amount zinc needed for the yield phenomenon. Conditio for producing yield points in face-centred cub metals are briefly discussed.

539.4.014.11 : 621.7

7994. The stresses in the reels of cold reduction mil R. B. SIMS AND J. A. PLACE. *Brit. J. appl. Phys.*, 213–16 (*July*, 1953).

The results indicated that the distribution is near

xially symmetrical, and it was concluded that Inglis's heory of wire winding might be adapted to give a easonable approximation of the stresses over the urface of a reel drum in the form of a thick-walled ube. This has been confirmed by the direct measurement of tangential stress in the lap of a coil next to he reel. A.

539.4.016.2

7995. The Bauschinger effect in some face-centred and body-centred cubic metals. R. L. WOOLLEY. *Phil. Mag.*, **44**, 597–618 (*June*, 1953).

The Bauschinger effect has been studied in Cu, Al, Pb, Ni and Fe, after deformations between 1% and 120%. The strain associated with the effect is shown to be approximately proportional to the stress applied to produce work-hardening, divided by the elastic modulus. It is independent of grain size. Its small dependence on temperature is explicable in terms of a thermal component of stress. It is slightly dependent on purity. The results agree with those of other workers, but disagree with the predictions of existing theories. A possible qualitative explanation of the effect is suggested. A.

539.4.016.2

7996. A theory of work-hardening of metals. II. Flow without slip-lines, recovery and creep. N. F. MOTT. *Phil. Mag.*, **44**, 742–65 (*July*, 1953).

For Pt I, see Abstr. 1991 (1953). The theory of work-hardening is extended to account for fine slip. It is suggested that fine slip and coarse slip both have their origin in Frank–Read sources, but that fine slip occurs when the dislocations move slowly. This occurs when the stress Gb/l required to obtain dislocations from a source is less than the stress required to drive them through the obstacles in the lattice without the help of thermal activation. The initial stages of deformation are normally by fine slip, and the hardening in this region is shown to be much slower than for coarse slip. In creep the deformation is normally by fine slip; a discussion is given on this basis of logarithmic creep, which agrees better with experiment than previous exhaustion theories. A new theory is given of Andrade's β-creep, which relates it closely to steady-state creep. Finally a discussion is given of the formation of vacancies during creep. A.

539.4.016.3

7997. On the phenomenon of recovery in artificially aged alloys of the type Al–Cu–Mg and duralumin. V. M. BEREZHIANI. *Dokl. Akad. Nauk SSSR*, **87**, *No.* 4, 563–6 (1952) *In Russian.*

Samples of 24S Al and of an Al alloy of similar composition were aged for 12 hr at 190°C and 18 hr at 165°C, respectively, then were heated rapidly (~1000°C/min) to temperatures in the range 260 to 500°C. At ~420°C an effect analogous to hardness-recovery in naturally aged alloys was observed, a new demonstration of the identity of natural and artificial ageing. NUCLEAR SCIENCE ABSTRACTS

539.42 : 539.133

7998. Effect of biaxial orientation on the ultimate strength and crazing of linear polymers. C. C. HSIAO AND J. A. SAUER. Letter in *J. appl. Phys.*, **24**, 957–8 (*July*, 1953).

Hsiao's theory [Abstr. 492 (1953)] is extended to the case of biaxial orientation. J. E. CAFFYN

539.42 : 666

7999. The relation between the resistance to rupture and the extent of cracking in glass. N. TERAO. *J. Phys. Soc. Japan*, **8**, 545–9 (*July–Aug.*, 1953) *In French.*

The relation between the extent of mirror surface appearing at the starting point of a crack produced in glass rod by bending, and the applied stress, is studied. Two series of experiments are carried out: (*a*) the load is increased linearly with time, (*b*) the load is kept constant. The greater the stress at the moment of rupture, the smaller the mean extent of mirror surface tends to be. Under the same condition of stress, however, marked fluctuations are observed in the extent of mirror as well as in the mode of successive ramifications. Statistical theory of fracture is applied. If the probability of the first occurrence of ramification which determines the boundary of the mirror, after the crack develops for the distance l from the starting point, is denoted by $\mu(l)$, the following relations are proved to hold good: $\mu(l) = A(l - l_0)\exp(\alpha f)$, when $l > l_0$, $\mu(l) = 0$, when $l \leqslant l_0$, $\bar{l} - l_0 = C\exp(-\alpha/2\,.\,f)$, where f is the tensile stress at the starting point of crack, l_0 the minimum extent of the mirror produced under stress f, $\bar{l}$ the mean value of l, and A, C, α, some constants. A.

539.42 : 666

8000. The resistance to rupture of glass—the influence of humidity. N. TERAO. *J. Phys. Soc. Japan*, **8**, 550–2 (*July–Aug.*, 1953) *In French.*

The influence on the strength of glass strip is studied. Marked fluctuations are observed in the strength as well as in the extent of mirror surface appearing at the starting point of fracture. By statistical analysis, it is found that the probability of breakdown when the load attains the value between f and $f + df$ is expressed by: $\mu(f)df = \alpha\exp[-(E_0 - \beta f)/kT]\,.\,df$. Here, E_0 is the activation energy of glass, βf the energy applied by external loading, T the absolute temperature and k the Boltzmann's constant. For the variation of humidity, β is kept constant, while E_0 decreases with increasing humidity. The effect of humidity is negligible to the extent of mirror, for which the following relation is proved to hold good: $\bar{l} - l_0 = C\exp(-\alpha/2\,.\,f)$. Here, $\bar{l}$ is the mean extent of mirrors produced by the load f, l_0 the minimum extent of mirror and C, α some constants. A.

539.431

8001. The growth of fatigue cracks. A. K. HEAD. *Phil. Mag.*, **44**, 925–38 (*Sept.*, 1953).

The qualitative features of the growth of a fatigue crack are discussed. A model is proposed which has these features and from which quantitative predictions can be made. These are in satisfactory agreement with experimental measurements. It is concluded that cracks may be formed at an early stage in fatigue, and that the growth of a crack may occupy a large part of the measured fatigue life. A.

539.576

8002. Contact and rubbing of flat surfaces. J. F. ARCHARD. *J. appl. Phys.*, **24**, 981–8 (*Aug.*, 1953).

The interpretation of certain phenomena occurring at nominally flat surfaces in stationary or sliding contact is dependent on the assumed distribution of the real area of contact between the surfaces. Since there is little direct evidence on which to base an estimate of this distribution, the approach used is to set up a simple model and compare the deduced theory (e.g., the deduced dependence of the experimental observables on the load) with the experimental evidence. The main conclusions are as follows. (*a*) The electrical contact resistance depends on the model used to represent the surfaces; the most realistic model is one in which increasing the load increases both the number and size of the contact areas. (*b*) In general, mechanical wear should also depend on the model. However, in wear experiments showing the simplest behaviour, the wear rate is proportional to the load, and these results can be explained by assuming removal of lumps at contact areas formed by plastic deformation; moreover, this particular deduction is independent of the assumed model. This suggests that a basic assumption of previous theories, that increasing the load increase the number of contacts without affecting the average size, is redundant.

539.(

8003. Internal friction in glass. I. Theoretic aspects. P. L. KIRBY. *J. Soc. Glass Technol.*, 3 7T–26T (*Feb.*, 1953).

Relationships between internal friction or dampi capacity and delayed elastic effects are discusse both effects being related to a quantity denoting t relaxation ratio of an anelastic process. The co nection between damping factors for oscillatory ar aperiodic stress-time phenomena is considere Suggestions are made concerning the probab relationships between the relaxation ratios (ar hence internal friction peaks in the acoustic spectru corresponding to different types of elastic deformatio The physical causes of anelasticity in glass are co sidered, including the effects of inhomogeneiti thermal diffusivity, ionic mobility and effective co figuration temperature, the result of which is to sugge reasons for the surprisingly small difference in t time order of elastic after-effects at room temperatu and those in the transformation range.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.11

8004. The effect of isotopic substitution on the entropy, enthalpy, and heat capacity of ideal gases. I. Systems in thermal equilibrium. II. Chemically reacting systems. J. BIGELEISEN. *J. chem. Phys.*, **21**, 1333–9 (*Aug.*, 1953).

The formulae of Bigeleisen and Mayer for the free energy difference between isotopic compounds are used to derive formulae for the similar differences in entropy, enthalpy, and heat capacity. Tables of these functions are calculated. The analogous quantities in the "thermodynamics of reactions rates" are discussed. Several useful formulae for the entropy differences of isotopic molecules are derived. A.

541.115

8005. Heat evolved during the reaction between carbon monoxide and caesium. R. SETTON. *C.R. Acad. Sci.* [*Paris*] **236**, 1959–60 (*May* 18, 1953) *In French.*

The heat of the reaction $n\mathrm{Cs} + n\mathrm{CO} = (\mathrm{COCs})_n$, as determined directly in a differential calorimeter is $-\Delta H_{291} = 37{\cdot}96 \pm 0{\cdot}52$ kcal/g.atom. F. LACHMAN

541.115

8006. Solutions of fluorocarbons and hydrocarbons; the energy of mixing. R. DUNLAP. Letter in *J. chem. Phys.*, **21**, 1293–4 (*July*, 1953).

A new, more general equation is derived for the energies of mixing of (saturated aliphatic) hydrocarbons and their completely substituted F derivatives. The new equation reproduces rather well the shape of the experimental energy/volume-fraction curves. F. LACHMAN

541.123

8007. Phase equilibrium in the system calcit aragonite. J. C. JAMIESON. *J. chem. Phys.*, 2 1385–90 (*Aug.*, 1953).

The equilibrium curve for two of the phases $CaCO_3$, calcite-aragonite, has been determined as function of temperature and pressure over the ran 25–80°c and several thousand kg/cm², using t electrical conductivity of aqueous solutions of ea form. Aragonite is proved to be the high pressu modification. From the determined equilibriu curve, various thermodynamic quantities are obtain in a more accurate fashion than previously possib All normal natural occurrences of aragonite must due to metastable formation rather than equilibriu since the geothermal gradient lies completely in t calcite field.

541.124 : 537.534.72 : 536.

The detection of atoms and free radicals in flames mass spectrometric techniques. *See Abstr.* 7629

541.1

8008. Free radicals by mass spectrometry. IV. T rate of combination of methyl radicals. K. U. INGO AND F. P. LOSSING. *J. chem. Phys.*, **21**, 1135– (*July*, 1953).

The rate of combination of methyl radicals pr duced by the thermal decomposition of mercu dimethyl has been studied with a free radical ma spectrometer over a large range of temperature (1 to 814°c) and at one temperature (735°c) over range of total pressure from 4·8 mm to 18·5 m The combination was found to be complex, consisti of a second-order homogeneous reaction and a fir order, presumably heterogeneous reaction. Only t

cond-order reaction was studied in any detail. ne rate constant or collision efficiency of this reaction as found to increase with decreasing temperature it showed no dependence on the carrier gas pressure. negative temperature coefficient was found for the mbination which, if expressed as an activation ergy, was $-2{\cdot}2 \pm 0{\cdot}5$ kcal. It seems, however, ore reasonable to regard this effect as a change in e effective collision diameter of the methyl radicals ith temperature, the change being due to the van der Vaals energy of attraction between the radicals. A.

541.127

009. Kinetic studies with a fast-scanning mass ectroscope. E. G. LÉGER AND C. OUELLET. Letter *J. chem. Phys.*, **21**, 1310–11 (*July*, 1953).

Describes briefly a spectroscope designed to study ne mass spectrum of reacting gases at intervals of a w milliseconds. Molecules travel from the reaction hamber through a 20 micron diameter hole to an ion ource, the ions being then accelerated by a saw tooth oltage towards the detector, a copper-beryllium ion-ectron multiplier. The output is presented on an scilloscope having the accelerating voltage for a me base, and photographed by cine camera. hotographs taken during a cool flame in a mixture f diethyl ether and oxygen are presented and analysed. H. H. GREENWOOD

541.127.4

010. Determination of the equilibrium constant, *K*, n solution. P. SAKELLARIDIS. *C.R. Acad. Sci. Paris*] **236**, 2500–2 (*June* 29, 1953) *In French.*

Theoretical. A general method of obtaining the quilibrium constant in solution for complexes is iven. It gives satisfactory agreement with the "continuous variation" method of Job. A. J. MEE

ELECTROCHEMISTRY 541.13

541.13

011. The electrochemistry of non-aqueous solutions. . G. ROE. *Rep. Brit. Elect. Res. Assoc., Ref. L/T*278, 7 *pp.* (1952).

Discusses the anomalous behaviour of certain veakly conducting organic solutions when subjected o a potential over a period of time. Various systems f picric acid in nitriles and ketones were used in the nvestigation and observations were made of the ariation of equivalent conductance with concentration and with time. A.

541.13

012. Demonstration, in a visible manner, of the nacroscopic electric charges formed within solutions n discontinuous regions of the electric field. J. LIMA-DE-FARIA. *C.R. Acad. Sci.* [*Paris*] **236**, 1961–2 (*May* 18, 1953) *In French.*

An experiment in which anomalous mobilities of he MnO_4^- ion are observed is described and explained by the formation of macroscopic electric charges. The relationship between this experiment and spark electrolysis is stressed. Another experiment, with bromophenol blue, also seems to involve the formation of such charges. [See also Abstr. 7245 (1953)].

F. LACHMAN

541.133

8013. Measurements of high-frequency conductivity in viscous solutions. A. CARRELLI AND L. RESCIGNO. *Nuovo Cimento*, **9**, 618–19 (*July*, 1952) *In Italian.*

Measurements have been made at $\omega = 8{\cdot}79 \times 10^8$ with KCl solutions in liquids of considerable viscosity, by the determination of maximum of resonance current. The conspicuous difference between l.f. and h.f. reported by other authors was not found. See also Abstr. 8293 (1951). A.

541.133

8014. Measurement of conductivity of strong and weak electrolytes at high frequency. A. CARRELLI AND L. RESCIGNO. *Nuovo Cimento*, **9**, 719–21 (*Aug.*, 1952) *In Italian.*

The results of experiments on strong and weak electrolytes, as to their conductivity at high and low frequency, are related. For the former the results of previous work [Abstr. 5373 (1950)] are confirmed; for the latter it is proved that the high frequency conductivity is the same as the low frequency. A.

541.133.08 : 621.317.331 : 621.317.73

8015. Apparatus for the measurement of ionic conductance of solid salts. P. W. M. JACOBS. *J. sci. Instrum.*, **30**, 204–7 (*June*, 1953).

An apparatus for the range 10^{-9} to $10^{-13}\ \Omega^{-1}\ cm^{-1}$ is described. The use of a l.f. pulse technique to avoid polarization together with the precaution of making all measurements in high vacuum, have enabled values of κ as low as $5 \times 10^{-15}\ \Omega^{-1}\ cm^{-1}$ to be determined. The performance of the apparatus is illustrated by the results obtained in the determination of the specific conductance of potassium and strontium azides. A.

541.135

8016. Determination of the relative electrode potential of an uncharged metal in solution. J. O'M. BOCKRIS AND R. PARRY-JONES. Letter in *Nature* [*London*] **171**, 930–1 (*May* 23, 1953).

Using a Herbert-type pendulum, the maxima of the $-\frac{1}{a}\frac{da}{dt}$/potential relations (where a is initial amplitude of oscillation and t is time) for Mn, Pb, Cd, Cu and Ni surfaces in aq. N 10 and N 100 HCl lie upon the linear relation which exists between the potentials of the electrocapillary maxima of Hg, Ga and Pt, and the work functions of these metals. It is suggested that the potential of the decay maximum is that of the electrocapillary maximum and so renders available an experimental method of determining the potential of a charge-free surface at a solid metal-solution interface. Rehbinder's explanation that the damping of the pendulum is due to reversible microfissure formation in the metal surface is shown to be invalid. H. H. HODGSON

541.135.5

8017. Mechanism of electropolishing. P. R. ROWLAND. Letter in *Nature* [*London*] **171**, 931 (*May* 23, 1953).

Au, Pt and Pd may be anodically polished using

pure molten KCl or NaCl as electrolyte. The method gives less brilliant results for baser metals such as Fe and Cu. The conditions at polishing and etching anodic surfaces are discussed. H. P. MYERS

541.135.5

8018. Electrolysis experiments confirming the inversion of the Hittorf phenomenon. S. SERNESSE. *C.R. Acad. Sci.* [*Paris*] **236**, 1963–4 (*May* 18, 1953) *In French.*

Presents results of measurements conducted in an improved electrolysis apparatus, using Pt electrodes for HCl and H_2SO_4, and Ag electrodes for HCl. The results seem to confirm the new interpretation of the inversion of the Hittorf phenomenon, based on the hydration of ions. F. LACHMAN

541.135.5

8019. A modification to the theory of inversion of the Hittorf phenomenon. L.-H. COLLET. *C.R. Acad. Sci.* [*Paris*] **237**, 252–4 (*July* 20, 1953) *In French.*

The interpretation already given [Abstr. 6536 (1951)] to the inversion of the Hittorf phenomenon, i.e. the change of sign of the variations of concentration in the vicinity of the electrodes during electrolysis, was in line with Hittorf's classical theory, and intended to emphasize the important role played by the hydration of ions. It was held that the variations of concentration were due not only to the transport of electrolyte but also to that of water of hydration by the ions, and that the volume of each electrode compartment was maintained by a reflow of the solution within itself. The ionic mobility is thus the sum of the mobility in a stationary medium and the velocity of the hydrodynamic reflow. The effect of the reflow on the electrolysis is now considered, and the expressions for the concentration variations are modified accordingly. H. H. HODGSON

541.135.5

8020. Solution of the Debye–Hückel equations for a polarized electrode. B. BREYER AND F. GUTMANN. *J. chem. Phys.*, **21**, 1323–6 (*Aug.*, 1953).

The Debye–Hückel equations are solved for the case of a polarized electrode, yielding, for the mean ionic concentration at a distance x from a plane cathode immersed into an aqueous solution of a uni-univalent electrolyte of concentration aN_0 molecules/cm^3, $n_1 = aN_0 \operatorname{cotanh}^2 Kx/2$, $1/K$ being the Debye length. The mean local charge density and the mean local potential are calculated, and it is shown that the latter quantity is merely the thermodynamical potential resulting from the increased activity of the cations near the electrode, the system behaving as a concentration cell. A.

541.138

8021. Review of electrochemistry of gases. S. C. LIND. *J. Electrochem. Soc.*, **99**, 344C–345C (*Dec.*, 1952).

A general review of the subject, mentioning the problem of the fixation of N from air, production of O_3, and, in particular, the work of Schoch [Univ. Texas Publ. Number 5011 (1950)] on the reaction between hydrocarbons in an electrical discharge. F. LACHMAN

PHOTOCHEMISTRY RADIATION CHEMISTRY 541.14/.15

541

8022. The photolysis of acetaldehyde, diacetyl : acetone at high intensity. M. A. KHAN, R. G. NORRISH AND G. PORTER. *Proc. Roy. Soc. A*, 2 312–27 (*Sept.* 22, 1953).

The photolysis of acetone, acetaldehyde and diac have been investigated at absorbed intensities of order 10^{-3} *Nhν* cm^{-3}s^{-1} which are greater by a fac of about 10^7 than those normally used. Precauti were taken to keep the system nearly isotherm Analysis of the products shows that, in this inten region, reactions which are second-order in rad concentration predominate, and no evidence found of any reaction of radicals with the pa molecule. In the case of acetaldehyde this result a complete change in the products, ethane forma being the main reaction of methyl, whilst in photolysis of acetone and diacetyl only m differences are observed. It has been possible to a fairly complete account of all the analytical res and the intensity dependence of the product ratic terms of reaction mechanisms which are log extrapolations of the results of studies at low inten The simplifications resulting from the eliminatio reactions with the parent molecule lead to informa concerning the primary photochemical acts and th second-order radical reactions which are of m importance at lower intensities.

541.14 : 542

8023. The photosensitized oxidation of para J. A. GRAY. Letter in *J. chem. Phys.*, **21**, 13 (*July*, 1953).

The possible subsequent reactions of atomi excited molecular oxygen which may be formed in quenching by oxygen proposed by Darwent [A 2021 (1953)] are discussed. An attempt is mad explain the failure to observe products which m reasonably be expected to arise from the quenc process. H. H. GREENW

541.14 : 542

8024. Bromination of hydrocarbons. VI. P chemical and thermal bromination of toluene. dissociation energies. H. R. ANDERSON, JR, H SCHERAGA AND E. R. VANARTSDALEN. *J. c Phys.*, **21**, 1258–67 (*July*, 1953).

For Pt V, see Abstr. 8303 (1951). With the a a high-temperature, high-vacuum, corrosion-resi valve and photometers operating with high sensi at low light intensities, it has been possible to the homogeneous gas-phase kinetics of the p chemical and thermal bromination of tol Infrared analyses indicated that the reactic predominantly a side-chain substitution, the pro being benzyl bromide and hydrogen bromide. photochemical reaction, studied in the temper range 82° to 132°C, was strongly inhibited by hyd bromide. The thermal reaction was studied i absence of added hydrogen bromide at 166°C. E for the step involving the dissociation of br molecules, both the photochemical and th

mechanisms involve the same type of atom and radical chain, as found previously for the bromination of simple alkanes. The corrected activation energy of the over-all reaction, as determined from the temperature coefficient of the photochemical reaction, was found to be 7·2 kcal/mole. This value was assigned to the rate determining step Br + RH = R + HBr. From the temperature dependence of the hydrogen bromide inhibition, the activation energy for the reverse of this step was assigned the value 5·0 kcal/mole permitting the C–H bond dissociation energy in the alkyl side chain of toluene to be estimated as 89·5 kcal/mole at room temperature. The discrepancy between this value and Szwarc's value of 77·5 kcal/mole from pyrolysis studies has been pointed out. The efficiency of toluene as a third body in the homogeneous recombination of bromine atoms, and also problems relating to steric effects in atom and radical reactions have been discussed. A.

541.15

8025. Degradation of polymers by gamma rays and neutrons. L. A. WALL AND M. MAGAT. *J. Chim. phys.*, **50**, 308–16 (*May*, 1953) *In French.*

The degradation of solid polymers by pile irradiation and of solutions of polymers by γ-rays has been followed by a viscometric method. In the first case, either an increase or a decrease in molecular weight can be produced by varying the structure of the polymer. The measured intrinsic viscosity can also be influenced by the presence of inhibitors in the solvents which are added to the solids after the irradiation. This is taken as a proof that immobilized free radicals exist in the irradiated solids. When solutions of large polymers are irradiated with γ-rays, oxygen is necessary for the degradation. In this case there is an after-effect which can be eliminated by adding an inhibitor during the irradiation.

C. B. ALLSOPP

541.15

8026. The decomposition of methanol-C^{14} under the influence of its own radiation. W. J. SKRABA, J. G. BURR, JR AND D. N. HESS. Letter in *J. chem. Phys.*, **21**, 1296 (*July*, 1953).

Gas collecting in ampoules of stored methanol-C^{14} was found to consist of hydrogen with 2% methane and no CO and amounted to 5·4 molecules per 100 eV dose from the 0·049 MeV β-particles. The residual methanol contained an oil which consisted of ethylene glycol with much smaller quantities of glycerol and erythritol. C. B. ALLSOPP

541.15

8027. Studies on the gamma-radiation-induced polymerization of acrylonitrile. I. A. BERSTEIN, E. C. FARMER, W. G. ROTHSCHILD AND F. F. SPALDING. Letter in *J. chem. Phys.*, **21**, 1303–4 (*July*, 1953).

The polymerization of acrylonitrile by Co^{60} γ-rays has been studied over a range of dose rates from 10 r/hr to 9400 r/hr under conditions in which oxygen or water vapour were rigorously excluded. The results for percentage polymerization do not agree with either a simple linear or square-root dependence on the dose rate. C. B. ALLSOPP

541.15

8028. Oxidation of ferrous sulphate in sulphuric acid by the radiations from radon and its active deposit. M. LEFORT. *C.R. Acad. Sci.* [*Paris*] **237**, 159–61 (*July* 15, 1953) *In French.*

The experimental conditions correspond to total absorption of α- and β-particles and partial absorption of γ-radiation by the water. Total oxidation of ferrous iron is produced and the production of ferric iron is proportional to total dose. At Fe concentrations between 10^{-4} and 10^{-2}M the G value is 7·5 for air-saturated solutions. No reduction of ferric iron is observed, but H_2O_2 is formed ($G = 1·6$). In the absence of air G for ferrous → ferric = 4·0.

C. B. ALLSOPP

541.15 : 534.321.9

8029. The oxidation of nitrogen by irradiation of water containing air with ultrasound. H. GOBRECHT AND H. ERGANG. *Z. Phys.*, **135**, *No.* 1, 85–91 (1953) *In German.*

Concentration of HNO_2 and HNO_3 determined by electrical conductivity measurements indicate the progress of oxidation. This occurs only above a certain intensity per unit volume, decreases with temperature and does not occur at all above 67°C.

T. C. TOYE

541.15 : 541.123.5 : 535.371

8030. Radiochemical microdosage of chlorine in luminescent zinc sulphide crystals. M. BANCIE-GRILLOT AND E. GRILLOT. *C.R. Acad. Sci.* [*Paris*] **237**, 171–3 (*July* 15, 1953) *In French.*

The action of neutrons on zinc sulphide phosphors provides a method of inserting precise amounts of chlorine of very low concentration compared with normal chemical methods. 10^{-6} g chlorine per 5 g ZnS can be detected. G. F. J. GARLICK

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18.041 : 539.169

8031. Application of β-irradiation and -emission to the study of the electrical precipitation of spherical particles (microscopic and sub-microscopic). R. CHALLANDE. *C.R. Acad. Sci.* [*Paris*] **237**, 35–6 (*July* 6, 1953) *In French.*

Previous work [Abstr. 8299 (1950)] has been verified using glass spheres which have been made radioactive by the use of an atomic pile. J. M. HOUGH

541.182.6

8032. New characteristic value in the flocculation of a sol by an electrolyte. R. AMIOT, Y. DOUCET AND G. WATELLE. *C.R. Acad. Sci.* [*Paris*] **236**, 1955–7 (*May* 18, 1953) *In French.*

When the electronegative sol of AgCl is flocculated by $NaNO_3$, KNO_3, $Ba(NO_3)_2$, $Sr(NO_3)_2$ and $Cu(NO_3)_2$ respectively, a characteristic concentration is found at which the flocculation rate passes through a maximum. The activity coefficient which corresponds to it is always ~0·800 whatever the valency of the cation, and appears to indicate anionic influence.

H. H. HODGSON

541.183

8033. The adsorption of gases at high saturations. I. The adsorption of nitrogen, argon and oxygen. R. BOWERS. *Phil. Mag.*, **44**, 467–84 (*May*, 1953).

The adsorption of argon, nitrogen and oxygen on an aluminium foil has been determined by a gravimetric method. The purpose of the investigation was to obtain data at high saturations for comparison with the Frenkel–Halsey–Hill equation describing multilayer adsorption. The isotherms obtained indicate that this equation is obeyed closely for the three gases. Apparent deviations in the case of argon and oxygen can be ascribed to anomalous packing in the first few atomic layers and allowance can be made for this effect. The verification is discussed in terms of the theoretical basis for the equation. Data are also given for the cross-sections of the argon and oxygen molecules in the first atomic layer. It is suggested that these cross-sections are considerably greater than values calculated from the corresponding bulk density. The magnitude of the standard nitrogen cross-section is also discussed. A.

541.183 : 536.48

The adsorption of gases at high saturations. II. The thickness of the unsaturated helium film. *See Abstr.* 7635

541.183 : 539.16.08

8034. Use of radioactive alpha-recoil in the study of soluble ionized surface layers. G. ANIANSSON AND N. H. STEIGER. Letter in *J. chem. Phys.*, **21**, 1299–300 (*July*, 1953).

Bi^{212} ions are dissolved in an acid solution of sodium dodecyl sulphate, and 50% of the recoiling Tl^{208} atoms reach the air space over the solution and are collected by a brass plate charged negatively. The activity of the plate is tested on a counter when a steady state has been reached. Since the surface layer has a thickness much less than the recoil range (1000 Å) the activity is proportional to the concentration of adsorbed Bi ions. S. J. GREGG

541.183 : 539.26/.27

Measurement of particle size of fine ferromagnetic powders. *See Abstr.* 7974

CHEMICAL STRUCTURE 541.2/.6

541.53

8035. The valency of the transition metals in some binary and ternary alloys. H. JONES. *Phil. Mag.*, **44**, 907–12 (*Aug.*, 1953).

The changes of valency of transition metal atoms in different alloy systems is considered. Reasons are given for expecting the valency to decrease as the electron concentration in the conduction band increases. Rough agreement with the experimental results of Haworth and Hume-Rothery [Abstr. 6789 (1952)] is obtained in the cases of Mn, Fe and Co. Suggestions are made to account for the apparent fractional valency of Ni. A.

541.57

8036. Chemical binding and electronic states in molecules. H. KUHN. *Experientia*, **9**, *No.* 2, 41–61 (1953) *In German.*

An elementary quantum mechanical treatment is given of chemical bonds. The dual character electrons and the expressions for their energies a discussed; the relations describing an electron in atomic field and in some other fields are derive The variational method and the Pauli principle a introduced. Unsaturated hydrocarbons are discuss qualitatively. A. J. TAYL

541.6

8037. Energy difference in rotational isomers of so dihalogenoethanes in the gaseous and liquid stat K. KURATANI, T. MIYAZAWA AND S. G. MIZUSHIM Letter in *J. chem. Phys.*, **21**, 1411–12 (*Aug.*, 1953).

Tabulates the experimental values of ΔE $E_{gauche} - E_{trans}$ and of wave numbers of absorpti peaks (*trans* and *gauche*) for $ClH_2C–CH_2C$ $ClH_2C–CH_2Br$ and $BrH_2C–CH_2Br$. F. LACHM

541.64 : 532.

8038. Degradation of polyisobutylenes on shearing solution. A. B. BESTUL AND H. V. BELCHER. *J. ap Phys.*, **24**, 1011–14 (*Aug.*, 1953).

The decrease of viscosity on shearing in a capilla at 37·8°c and a nominal rate of shear of 65 000 sec has been measured for 5, 10 and 15 weight-per ce solutions in *o*-dichlorobenzene of 10 polyisobutyler having viscosity-average molecular weights fr 40 000 to 2 300 000. Very little, if any, viscos decrease was observed for polymers having molecu weights below 500 000, but marked decreases we observed for polymers with molecular weights abc 500 000. The observed decreases were not recover on standing and correspond to appreciable decrea in the molecular weights of the polymers. T molecular weight reduction can be explained on t basis of polymer chain rupture if the mechani energy developed in a volume less than that envelop a single polymer molecule can be concentrated in a single bond.

541.64 : 532

Dependence of diffusion rate on the concentration some polymers in solution. *See Abstr.* 7499

541.64 : 535.

Scattering factors for certain polydisperse syste *See Abstr.* 7615

541.64 : 538.

8039. Dimerization in NaF. P. KUSCH. Letter *J. chem. Phys.*, **21**, 1424 (*Aug.*, 1953).

Evidence of polymerization of NaF in the gase phase, obtained from observations by the molecu beam magnetic resonance method at low magn fields, is discussed. G. I. W. LLEWEL

541.64 : 539

8040. Effect of (inter)molecular attraction on strength of high polymers with developed spa structure. V. E. GUL'. *Dokl. Akad. Nauk SS* 85, *No.* 1, 145–8 (1952) *In Russian.*

By assuming that the contribution of intermolecu attraction in high polymers to the total strength a viscous resistance to flow, and using Frenk exponential expression for η, it is deduced t $P = P_x + E\tau_0(v/l)\exp(U/RT)$, where P = tc strength, P_x = contribution from chemical bo forces, E = elasticity modulus, τ_0 = period of vib tion of kinetic units around the mean positi

v/l = rate of shear, U = energy of activation for transition from initial to final positions. This equation, indicating that there is a linear relationship between $\ln P$ and $1/T$, and between $\ln P$ and $\ln v$, is in good agreement with Dogadkin and Sandomirskii's experimental results. R. C. MURRAY

541.64 : 541.183 : 532.73

8041. Adsorption on proteins and interactions between protein molecules in solution. T. L. HILL. *J. chem. Phys.*, **21**, 1395–6 (*Aug.*, 1953).

A theoretical approach to the problem of the interconnection between adsorption on proteins and interactions between protein molecules in solution is outlined. As an illustration, the second virial coefficient and related quantities are discussed. A more detailed account will be published in the Annals of the New York Academy of Sciences. A.

LABORATORY APPARATUS 542.1/.7

542.2 : 621.34 : 621.318.3

8042. A.C. liquid metal pumps for laboratory use. D. A. WATT. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. No. CE/R* 1089, 9 *pp.* (1953).

Two types of 1-ph. a.c. electromagnetic pump for liquid metals are described, a leakage reactance model and a combined pump and transformer. The Na–K alloy test rig is briefly described and methods of pump construction detailed. Test results and curves for pumping NaK alloy at temperatures below 70°c are included and it is shown that the combined form is the more effective pump. One of these models with a single loop secondary winding had a maximum efficiency of 11% with output 10 gall/min at 13 lb/in² pressure rise, input 650 W, 9·0/7·5 A at 180/195 V. A maximum pressure rise of nearly 30 lb/in² is recorded for the first model of this form. A.

CHEMICAL ANALYSIS 543/545

545.828 : 535.33.03

Contribution to the methods and technique of flame spectrography and flame photometry. *See Abstr.* 7549–50

CRYSTALLOGRAPHY 548

548.0 : 535.5

8043. Alleged optical activity in crystal class *m*. D. ROGERS. Letter in *Nature* [*London*] **171**, 929 (*May* 23, 1953).

The dimer of β-methylmesityl oxide oxalate $(C_9H_{12}O_4)_2$ does not belong to class *m* [as claimed by Sommerfeldt: *Neues Jahrbuch fur Mineralogie*, **1**, 58 (1908)] but has space group $P2_1/c$. Twinning occurs with $(10\bar{2})$ and [010] in common; this accounts for Sommerfeldts' observation of optical activity. Investigations on real examples of class *m* crystals are desirable. C. TURNER

548.1 : 519.2 : 593.3 : 539.2

Matter tensors in symmetrical systems. *See Abstr.* 7965

548.5

8044. On a growth front of Zn and Cd crystals. F. BLAHA. Note in *Naturwissenschaften*, **40**, *No.* 8, 240 (1953) *In German.*

Crystals, grown by pulling a seed crystal from the melt so that thickening in addition to lengthening occurs, exhibit vicinal surfaces. The appearance of the growth front of a Zn crystal is illustrated; Cd is stated to behave similarly. S. WEINTROUB

548.5

8045. Theory of decomposition of the supersaturated [solid] solutions. I. V. SALLI. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 1, 61–4 (1953) *In Russian.*

For the diffusion of the crystallizing substance through a [hemi-]spherical layer surrounding the growing crystal, the following equation has been derived: $dq/dt = 4\pi D(\Delta - a/r)(1/r + 1/x)r^2$, where q is the amount of the diffusing substance; t, time; D, diffusion coefficient; Δ, the difference between the concentration of the supersaturated solution and that at the flat boundary; r, radius of the crystal sphere; x, thickness of the surrounding layer that is poorer in the crystallizing substance; and $a = 2\sigma M v C_\sim/RT$ (from Thompson's formula), where $C_\sim$ is the concentration at the flat boundary; σ, the interfacial tension at the phase boundary; M, the molecular weight of the separating phase; v, its specific volume. The equation is analysed for the following cases: (1) hemispherical crystal growth, the thickness of the lower-concentration layer increasing as the crystal size increases (usually encountered in not too supersaturated solid solutions); (2) crystal growth when the thickness of the lower-concentration layer remains constant (mainly in the case of the decomposition of liquid solutions, particularly the more viscous ones, e.g. during the growth of the cementite and graphite lamellae when ultra-eutectic pig-iron solidifies, but also in solid solutions, e.g. the growth of the cementite lamellae during the eutectoid decomposition of austenite). F. LACHMAN

548.5

8046. Theory and observations on the growth of crystals of salol. S. AMELINCKX. *J. Chim. phys.*, **50**, 218–25 (*April*, 1953) *In French.*

Salol (phenyl salycilate) crystals, grown from a solution in which they float, show spiral-walled depressions on their upper surfaces. These are explained in terms of a theory somewhat different from that of Burton, Cabrera and Frank [Abstr. 6560 (1951)], but requiring the existence of a screw dislocation at the centre of the growth spiral. A. R. STOKES

548.5

8047. Observations on slip found in a diamond. S. TOLANSKY AND M. OMAR. *Phil. Mag.*, **44**, 514–18 (*May*, 1953).

Interferometric and optical studies on a twinned diamond reveal the presence of true crystallographic slip on two opposite faces of the twin. Slip occurs parallel to a (111) plane, in both cases, making thus an angle of 70½° with the surface. An internal optical opacity is found associated with the slip. The two faces on either side of one slip line are not parallel but inclined at the very small angle of 10^{-5} radian. A.

548.5

8048. Inhomogeneity of thallium halide mixed crystals and its elimination. A. SMAKULA, J. KALNAJS AND V. SILS. *J. Opt. Soc. Amer.*, **43**, 698–701 (*Aug.*, 1953).

Prisms, cut from mixed crystals of thallium halides, as they are used at present for infrared spectroscopy, show optical inhomogeneity which causes an undesirable decrease of resolution. By chemical X-ray diffraction and thermal analysis it was possible to trace the cause of this defect to the use of incorrect data of the minimum melting points of the compositions from which the crystals were grown. The melting points of the thallium halides and of their binary systems have been redetermined, and crystals grown from compositions corresponding to the accurate minimum melting points have been found to be entirely homogeneous. A.

548.5 : 539.23

8049. Linear film growth in tarnishing reactions. R. C. WILLIAMS AND P. R. WALLACE. Letter in *J. chem. Phys.*, **21**, 1294–5 (*July*, 1953).

The growth of AgCl on Ag in triphenylmethyl chloride is considered theoretically. It is stated that, in the early stages of film growth, the basic mechanism of growth is the tunnelling of electrons through the tarnishing film, while thermionic emission of electrons is a process which is insufficient to sustain the reaction. The authors suppose that when the film has reached a thickness of about 80 Å, at a temperature slightly above the critical temperature for film formation, growth is limited by excitation of electrons from the valence band of AgCl into Cl^- surface states. This leads to a logarithmic rate of growth followed by linear rate of growth, at this temperature. At higher temperatures the logarithmic rate of growth is followed by a parabolic rate of growth in agreement with the current theory of tarnishing reactions. These ideas are in agreement with recent experiments by Perry and Winkler [*Canad. J. Chem.*, **30**, 235 (1952)]. P. T. LANDSBERG

548.52

8050. On tin whiskers. F. C. FRANK. *Phil. Mag.*, **44**, 854–60 (*Aug.*, 1953).

The growth of tin whiskers is explained as a process in which oxidation of the whisker surface develops a stress which draws out a continuing thread of metal from the main mass. A mechanism is provided by a dislocation in the main mass which travels continuously around the root of the whisker. It then follows that the whisker axis should be parallel to the Burgers vector of the dislocation, i.e. a slip direction in th crystal. All that is needed to start the process is a oxidizing or other reactive atmosphere, a small kno on the surface, and a dislocation. The order magnitude of the growth rate can be satisfactori accounted for. The substantially uniform thickne of whiskers is explained because the growth ra increases rapidly with diminution of radius, b below a certain radius the process fails because t tensile stress at the root fractures the whisker. T angular bends produced in whiskers subjected to very high bending stress is attributed to an unusu kind of deformation twinning.

548.5

8051. Preparation of single crystals of sem conducting compounds of the type $A^{III}B^V$. R. GRE MELMAIER AND O. MADELUNG. Note in *Z. Natu forsch.*, **8a**, 333 (*May*, 1953) *In German.*

The preparation of single crystals of InSb an AlSb by pulling from a melt in a graphite crucible described. The process is carried out in nitrogen argon and a sensitive temperature-regulating devi is required. C. A. HOGART

548.5

8052. The thermal etching of uranium. B. V MOTT AND J. WILLIAMS. *Phil. Mag.*, **44**, 841- (*Aug.*, 1953).

Particular reference is given to the formation steps on beads of metal produced by melting t powder.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548

8053. Band structures of one-dimensional crysta with square-well potentials. G. ALLEN. *Phys. Re* **91**, 531–3 (*Aug.* 1, 1953).

The energy band structure for a one-dimensio periodic square-well potential is obtained in terms the well depth for the whole range of possible rati of well width to hill width. This model bears a clos resemblance to a real crystal since, as potential dep is varied for a fixed ratio of well width to hill widt the curves bounding distinct bands cross while in t case of a δ-function potential no such crossin occur. The location of these crossings is derive The number of times that a given pair of bounda curves can cross is considered. For the set boundary curves that belong to a given ratio well-to-hill widths, this number is unbounded.

548

8054. Determination of the oscillations of therm agitation of the atoms engaged in a crystal: case the fluorine-type structure. D. CRIBIER. *Acta crys* **6**, 293–300 (*March*, 1953) *In French.*

The frequency and form of thermal vibrations a determined by the Fourier matrix. If the crystalli motif is composed of g atoms, this is a Hermiti matrix of order $(3g \times 3g)$ containing (for an asy metrical crystal) $3g(3g + 1)/2$ elements. Just as t crystal symmetry reduces the number of coefficie of elasticity, so it reduces the number of independe

lements of the Fourier matrix and permits the lgebraic nature of these elements to be determined. n this paper the symmetry operations are applied to letermine the number of independent elements in the Fourier matrix of the structure of fluorite, CaF_2, and o determine the nature of the atomic oscillations when these oscillations are controlled by vectors parallel to the symmetry axes. The oscillations controlled by wave vectors parallel to the tetrad or triad axes are transverse degenerate or rectilinear longitudinal. The oscillations of the calcium atoms controlled by a wave vector parallel to the diad axes are rectilinear, longitudinal or transverse. Three of the oscillations of a fluorine atom controlled by a wave vector parallel to the diad axes are rectilinear longitudinal; the six other oscillations are elliptical, the plane of vibration being defined by the diad axis parallel to the wave vector and the perpendicular tetrad axis. A.

548.7

8055. Dispersion of oscillation frequencies which form the thermal agitation of atoms in sodium chloride. P. MÉRIEL. *C.R. Acad. Sci.* [*Paris*] **236,** 1900–2 (*May* 11, 1953) *In French.*

The 9 elements of the dynamical matrix of Born, attached to 2 atoms, form a second-order tensor. These tensors can be determined for the 3 nearest neighbours of the central atom; forces due to 2nd and 3rd neighbours are central in Born's sense, and action from higher-order neighbours is negligible. Using Voigt coeffs. in the characteristic equation of the Fourier matrix, dispersion curves are obtained, as functions of the wave vector directed along the axes of symmetry of the crystal. J. JACOBS

548.7

8056. One-dimensional disorder in dodecahydrotriphenylene, $C_{18}H_{24}$. F. HALLA, H. JAGODZINSKI AND W. R. RUSTON. *Acta cryst.*, **6,** 478–86 (*June*, 1953).

A modification of dodecahydrotriphenylene, $C_{18}H_{24}$, has been found, different from that investigated by Chorghade. Rotation diagrams about [0001] show diffuse row lines and those about [1000] show diffuse layer lines. The cell has the dimensions $a' = 10{\cdot}45$, $c' = 15{\cdot}50$ Å; $n = 4$, and may be reduced to a statistically occupied cell with the dimensions $a = 5{\cdot}86$, $c = 7{\cdot}75$ Å; $n = \frac{1}{2}$. The disorder phenomena are the same as occur in closest packings of spheres. The intensity distribution on the row lines can be interpreted quantitatively by Wilson's theory, as extended by Jagodzinski. A.

548.7

8057. On the space correlation of the outer electrons in crystal chemistry. K. SCHUBERT. Note in *Naturwissenschaften*, **40,** *No.* 9, 269–70 (1953) *In German.*

A preliminary discussion of types of binding which depend on correlations between the outer atomic electrons. P. T. LANDSBERG

548.7

8058. Dislocations in anisotropic material. G. LEIBFRIED. *Z. Phys.*, **135,** *No.* 1, 23–43 (1953) *In German.*

This paper is an extension of the work of Burgers (1939) on the elastic dislocations in isotropic materials and crystals with cubic symmetry. Simplifying assumptions are made to give an approximate theoretical treatment for anisotropic materials. Screw and edge dislocations are discussed and the elastic coefficients of cubic and hexagonal crystals are evaluated. H. J. H. STARKS

548.7

8059. A model for demonstrating dislocations in crystals. H. G. VAN BUEREN. *Brit. J. appl. Phys.*, **4,** 144–5 (*May*, 1953).

A simple dynamic model, in which the interatomic forces are simulated partially by magnetic forces, partially by the elastic forces exerted by small springs, is described. With it the movement of edge and screw dislocations through a crystal lattice can easily be demonstrated. A.

548.7

8060. Structures of the ReO_3-type with recurrent dislocations of atoms: "homologous series" of molybdenum and tungsten oxides. A. MAGNÉLI. *Acta cryst.*, **6,** 495–500 (*June*, 1953).

The geometrical properties of structures of the ReO_3-type showing recurrent dislocations of atoms, analogous to those present in Mo_8O_{23}, Mo_9O_{26} and $W_{20}O_{58}$, are discussed. Two of the hypothetical atomic arrangements thus derived have been found to correspond to recently prepared molybdenum tungsten oxides $(Mo, W)_{10}O_{29}$ and $(Mo, W)_{11}O_{32}$. These compounds and the aforementioned molybdenum oxides are members of a "homologous series," Me_nO_{3n-1}, based on a common structural principle. There is almost complete agreement between the experimentally derived structures of these homologues and the corresponding ideal structures. The same is also true for $W_{20}O_{58}$, the only hitherto known representative of the series Me_nO_{3n-2}. A.

548.7

8061. Contribution to the study of defect structures: pyrrhotite. E. F. BERTAUT. *Acta cryst.*, **6,** 557–61 (*June*, 1953) *In French.*

The distribution of holes in pyrrohtite, a defect structure, is ordered. The supplementary potential energy associated with the ordering of the holes has been computed, using Ewald's theory of electrostatic potentials. It proves to be so large that it can be expected that all ionic defect structures of this kind are ordered. A.

548.7

8062. Reversible bleaching of a band in the absorption spectrum of diamond. P. PRINGSHEIM. *Phys. Rev.*, **91,** 551–4 (*Aug.* 1, 1953).

When diamonds which show the absorption band in the near ultraviolet, characteristic of blue fluorescing samples, are exposed to neutron bombardment, a continuous absorption slowly rising toward shorter wavelength is superimposed upon the band. Heating such a diamond to temperatures between 300° and 600°c decreases the continuous absorption and the structure of the band becomes appreciably sharper. Subsequent exposure to light greatly reduces the height of individual peaks in the band, while the continuous absorption at shorter wavelengths is

increased. Renewed heating restores the sharp structure of the band and the cycle can be repeated at will. Heating the crystal to 750°c brings the crystal very nearly back into the state before neutron bombardment in which the reversible bleaching cannot be observed. A similar band accompanies the sharp line at 503 mμ that is produced in the absorption spectrum of diamonds by neutron bombardment and heat. The structure of this band is also altered by heating to various temperatures but is not affected by absorption of light. A.

548.7 : 537.312.5

Irradiation-induced photoconductivity in magnesium oxide. *See Abstr.* 7682

548.7 : 541.138

8063. The electrochemistry of ionic crystals. C. WAGNER. *J. Electrochem. Soc.*, **99**, 346C–354C (*Dec.*, 1952).

A well-referenced review (119 items). Discusses the analogies and differences between problems of aqueous solutions and those of ionic crystals. The latter are much more complex, if only due to the various types of lattice defects which may contribute to conductivity of pure compounds. Describes and discusses the mechanisms of ionic and electronic conduction, the degree of disorder in Ag halides and alkali halides, and the diffusion process and chemical reactions involving ionic crystals. It is shown how the constitution of the various systems can be derived from the results of conductivity and transference measurements, equilibrium investigations, and X-ray investigations. F. LACHMAN

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 7974–84

548.73

8064. International tables for X-ray crystallography. I. Symmetry groups. Edited by N. F. M. HENRY AND K. LONSDALE. *Birmingham: Kynoch Press* (1952) xi + 558 *pp.*

Review in *Proc. Phys. Soc.* [*London*] *A*, **66**, 497–9 (*May*, 1953).

548.73

8065. X-ray crystallography. R. W. JAMES. 5th Ed. *London: Methuen*, x + 101 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 191 (*June*, 1953).

548.73 : 539.32

8066. Determination of elastic constants of crystals from diffuse reflexions of X-rays. III. Diamond. E. PRINCE AND W. A. WOOSTER. *Acta cryst.*, **6**, 450–4 (*June*, 1953).

For Pt II, see Abstr. 9132 (1951). The intensity of diffuse X-rays thermally scattered from a Type II diamond has been studied by means of a Geiger-counter spectrometer. To increase the intensity of the diffuse radiation, the crystal was heated to about 300°c and observations were made in various directions in reciprocal space passing through the reciprocal point 220. Following the method of Ramachandran and Wooster [Abstr. 9131 (1951)] the elastic ratios were determined as $c_{12}/c_{11} = 0{\cdot}30 \pm 0{\cdot}02$; $c_{44}/c_{11} = 0{\cdot}40 \pm 0{\cdot}02$. The absolute values were determined by comparing the intensity of the Compton radiation scattered at an angle of 90° by the crystal, with th intensity of the thermal diffuse X-rays. The valu obtained were $c_{11} = 110\times10^{11}$; $c_{12} = 33\times10^{11}$; $c_{44} = 44\times10^{11}$ dyne cm^{-2} and the accuracy was abo ±10%. These values are compared critically wi those determined by an ultrasonic method by Bhag vantam and Bhimasenachar and it is concluded th their value of c_{12} is too high and their value of c probably too low.

548.7

8067. The diffraction of X-rays by bent crystal Kinematic theory—case of transmission. I. BOROVSKIĬ AND P. A. BEZIRGANYAN. *Dokl. Aka Nauk SSSR*, **88**, *No.* 4, 639–42 (1953) *In Russian.*

Theoretical. Conditions are derived for t positions and intensities of diffraction maxi resulting from the incidence of X-rays on a cryst bent into part of a circular cylinder. The diffracti from a plane array of points arranged in a rectangul net is first calculated and the resultant waves fro several such planes, all intersecting the axis of t cylinder is found by summation. Certain appro mations are introduced it being assumed that t angles between adjacent planes are very small. T conditions reduce to those calculated by Laue wh the crystal has an infinite radius of curvature.

A. L. MACK

548.7

8068. The diffraction of X-rays by bent crysta Kinematic theory—case of reflection. I. B. BOROVS AND P. A. BEZIRGANYAN. *Dokl. Akad. Nauk SSS* **88**, *No.* 5, 769–72 (1953) *In Russian.*

See preceding abstract. The formulae alrea derived are used to find the positions and intensit of the maxima of X-ray beams diffracted from t concave side of a crystal bent into a cylinder.

A. L. MACK

548.

8069. The X-ray scattering from a hindered rotat II. M. ATOJI, T. WATANABÉ AND W. N. LIPSCO *Acta cryst.*, **6**, 62–6 (*Jan.*, 1953).

For Pt I, see Abstr. 4485 (1950) [in line 3, (*No.* 3) read (*No.* 2)]. The Laue–Bragg scatter from a group of atoms undergoing hindered rotat has been derived for a generalized potential functi this should permit treatment of a non-sinusoi potential function as well as the non-classical rota provided its probability distribution is known. T diffuse scattering from a hindered rotator is deriv and shown to be very sensitive to the degree hindrance. A method of deriving the scatter from a spacially hindered rotator is also presented.

548.

8070. Charts giving the characteristics of b crystal X-ray monochromators. J. BERTHELOT, RÉRAT AND A. J. ROSE. *J. Rech. Cent. Nat. R Sci.*, **5**, 55–60 (*March*, 1953) *In French.*

Given the wavelength, the radius of curvature the reflecting planes and their angle with the surf of the crystal, one can read off the distances of source and the focus from the centre of the plate.

A. R. STO

548.733

8071. A note on temperature control during lattice spacing measurements. H. J. Axon, A. Hellawell, D. M. Poole and W. Hume-Rothery. Note in *Brit. J. appl. Phys.*, **4**, 188–9 (*June*, 1953).

Errors can arise when a thermometer outside the camera is used, owing to heating effect of a built-in motor, slow approach to temperature equilibrium between inside and outside, thermal radiation falling on the camera, etc. A. R. STOKES

548.733

8072. A new X-ray camera for the study of back-reflections. Application to quartz. G. Sabatier. *C.R. Acad. Sci.* [*Paris*] **237**, 77–9 (*July* 6, 1953) *In French.*

The camera uses an adaptation of Rowland's mounting (1883) for concave gratings. Some measurements of the parameters of quartz are briefly reported. A. R. STOKES

548.734

8073. Optimum geometric conditions in the design and use of X-ray diffraction tubes and cameras. H. E. Huxley. *Acta Cryst.*, **6**, 457–65 (*June*, 1953).

A theory is developed which enables optimum geometric conditions to be determined under various conditions. The validity of the simplifying assumptions is discussed. The theory shows (*a*) that stationary-anode X-ray tubes should be employed with focal dimensions three times those of the specimen; (*b*) that rotating-anode X-ray tubes should have focal dimensions five times those of the specimen. In each case, the distance between specimen and focus and the film distance are determined by the spacings which it is desired to record. Optimum conditions are also calculated for cases where the focal size, specimen distance, and/or film distance are restricted by experimental conditions. The dosage received by the specimen and the contrast produced at the film are also considered. The implications of this analysis are discussed, and, in particular, it is concluded that a need exists for X-ray tubes of variable focal size. A.

548.735

8074. A new photomechanical method of calculating atom-distributions in amorphous substances. H. Krebs, R. Thees and W. Meyer-Eppler. Letter in *Naturwissenschaften*, **40**, No. 14, 389–90 (1953) *In German.*

The method uses an illuminated screen giving the X-ray intensity function to be transformed, a sine-fuction raster, and a photo-cell. A trial with a known function is described. A. R. STOKES

548.735

8075. The use of low temperatures in accurate structure analysis. R. D. Burbank. *Acta cryst.*, **6**, 55–6 (*Jan.*, 1953).

The standard errors in a structure analysis are decreased both by a reduction in the ΔF's and by an increase in the curvatures of the electron density at peak centres. At low temperatures the peak curvatures are increased as a consequence of reduced thermal vibrations. It is possible that the standard errors in many organic structures could be reduced by a factor of two by recording diffraction data at low temperatures. A.

548.735

8076. Crystal structure analysis giving unique determinations. II. The separation of the Q_0 function. R. Hosemann and S. N. Bagchi. *Acta cryst.*, **6**, 318–25 (*April*, 1953) *In German.*

For Pt I, see Abstr. 7310 (1953). The Q-function, as obtained by inverse Fourier transformation from the continuous intensity distribution of crystal diffraction is, in contrast to the Patterson-function, always a "quasi-periodic" function. It is generated by a special type of superposition of the Q_0-functions, i.e. Q-functions of a single crystal cell, each of which is shifted against the other in a manner somewhat similar to the arrangement of the tiles on a roof ("tile-structure," *Dachziegelstruktur*). The Q_0- functions can be calculated as the quotient of two determinants whose terms are obtained uniquely from the quasi-periodic Q-function. The Q_0-function is the square of convolution (*Faltungsquadrat*) of the electron-density distribution ρ_0 in a lattice cell. In the case of the electron-density distribution having a centre of symmetry, ρ_0 can be uniquely calculated from the Q_0-function with the help of a convolution polynom, as was shown in Pt I. In the conventional method of classical crystallography the fine structure of the reflections is neglected and only their integral intensities are used. The Q-function then degenerates to the well-known Patterson-function which unfortunately shows no "tile-structure." A separation of the Q_0-function is then impossible since both determinants become zero. Moreover, the direct analysis of the Q-function (here Patterson-function) with the help of convolution polynomes is not possible as no boundary value exists for such a Q-function. The Q-functions of two special homometric functions consisting of a small array of two-dimensional lattice cells have been successfully analysed. A.

548.735

8077. The calculation of the Q_0 function from the experimentally determined intensity distribution of a bounded crystal. R. Hosemann and S. N. Bagchi. *Acta cryst.*, **6**, 404–13 (*May*, 1953) *In German.*

It is proved that the knowledge of the structure factor and of its gradient in each point of the reciprocal lattice is sufficient to calculate exactly the Q_0-function of a crystal in its dependence on the respective Fourier coefficients. The Q_0-function is defined as the square of folding (*Faltungsquadrat*) of the electron-density distribution in a single lattice cell of the crystal. It is further shown how the gradient of the structure factor can be calculated from experimental data. For this purpose it is sufficient to use an approximate representation of the shape of the principal diffraction maximum of each reflection by ten parameters. These parameters are: maximum (not integral) intensity of a reflection and its displacement from the corresponding point of the reciprocal lattice and six components of a symmetrical tensor of the "effective" shape factor. It is also shown that for a not too small crystal and for reflections which are not too weak this tensor of the "effective" shape factor is practically the same as that obtained in

Guinier's approximation. Two two-dimensional homometric structures of "point atoms" are discussed from this point of view. A.

548.735

8078. Weighting of the least-squares and steepest-descents methods in the initial stages of the crystal-structure determination. M. M. Qurashi and V. Vand. *Acta cryst.*, **6**, 341–9 (*April*, 1953).

The behaviour of the methods of steepest descents and least squares in the initial stages of the crystal-structure determination, when the differences between the assumed and the correct positions of the atoms are large, depends on the choice of the weighting function. Various simple laws are assumed for the weights, and the "efficiency of convergence" is calculated for the case of known signs of the observed F's; only the power law is found to be suitable. It is shown that only for weighting which corresponds to a large "artificial temperature factor" is there a unique solution for large displacements; the overlapping of atomic peaks is also discussed in detail. Analysis of these two effects leads to the determination of the optimum value for the exponent in the power law. Curves are drawn from which the corrections to be applied to the calculated displacements can be obtained for one-, two- and three-dimensional summations. A.

548.735

8079. The probability distribution of X-ray intensities. V. A note on some hypersymmetric distributions. D. Rogers and A. J. C. Wilson. *Acta cryst.*, **6**, 439–49 (*June*, 1953).

For Pt IV, see Abstr. 5915 (1951). The parallel repetition of a motif modulates the Fourier transform of the motif by the transform of the repetition arrangement, thus increasing the dispersion of the resultant transform. Several arrangements are considered in which the repetition involves the introduction of non-crystallographic symmetry. Statistical criteria are evaluated for the recognition of each of the resulting distributions and some comments are offered on the correlation of the statistical evidence for parallelism with that given by inspection of the reciprocal lattice or by the Patterson function. A.

548.735

8080. A method for the estimation of transmission factors in crystals of uniform cross section. N. Joel, R. Vera and I. Garaycochea. *Acta cryst.*, **6**, 465–8 (*June*, 1953).

Presents a method of estimating the transmission factors [absorption factors] of crystals with uniform cross-section. It synthesizes Albrecht's idea of dividing the section into parallelograms and measuring the path length x for the centre of each, with Howells's loci of points of constant x. Thus, bands of approximately constant x are obtained, which makes the computations very quick. An example and a detailed discussion on the accuracy to be expected are also given. A.

548.735

8081. A three-dimensional coordinate model for demonstration of inorganic crystal structures. A. J. E. Welch. *Acta cryst.*, **6**, 476–7 (*June*, 1953).

A transparent plastic framework is described in which coloured pins may be inserted to show t arrangements of atoms in simple unit cells.

548.7

8082. The interpretation of diffuse X-ray reflexi from single crystals. II. J. Hoerni and W. Wooster. *Acta cryst*, **6**, 543–7 (*June*, 1953).

Pt I [Abstr. 9163 (1952)] dealt with geometri aspects of the photographic study of diffuse X-r reflections from single crystals. The present pa deals with factors affecting the intensity of th reflections. The method of making the observati varies according to whether the diffusely-scatter reciprocal region has the form of a cloud, a disk rod or a point, and the appropriate method for e is indicated. Divergence corrections are descri which make allowance for the fact that the beam not infinitely narrow and the crystal is not ide perfect. The final intensity correction applies reflections which occur off the equator of the pho graph.

548.

8083. Statistical treatment of errors in the case a pseudocentrosymmetric structure. V. Luzz *Acta cryst.*, **6**, 550–2 (*June*, 1953) *In French.*

A statistical calculation has been used to deter a relation between the empirical funct $\langle(F_o^2 - F_c^2)^2\rangle/\langle F_c^4\rangle$ and the mean error in ato positions in the following cases: (*a*) F_o and F_c n centrosymmetrical; (*b*) F_o and F_c centrosymmetri (*c*) F_c centrosymmetrical, F_o non-centrosymmetri (*d*) the analogue of (*c*) but in which the atoms approximately situated on a symmetry element.

548

8084. An analysis of the efficiency of convergenc different methods of structure determination. I. methods of least squares and steepest descents: cen symmetric case. M. M. Qurashi. *Acta cryst.* 577–87 (*July*, 1953).

A theoretical derivation of the "efficiency of vergence" of the methods of least squares and stee descents is given for large departures of the assu approximation from the correct structure. The e of incorrect signs is considered in detail and a ma matical expression is obtained for the efficienc convergence, η, for an n-dimensional summat (The effect of overlapping atoms and of unobserv weak reflections is also discussed.) It is shown th can be expressed as a function of $u = 2\pi\Delta/$ where Δ is the root-mean-square error per at co-ordinate. The characteristic behaviour of η u various conditions is discussed, and approxi expressions are obtained for the radius of r convergence, within which it is possible to spee the convergence by using the theoretical value Curves to facilitate this are drawn, and a nume example of their application is given.

548

8085. Calculated powder patterns from very s crystals: body-centered cubic cubes. C. Moro and H. L. Ritter. *Acta cryst.*, **6**, 588–90 (*July*, 1

The X-ray scattering patterns of several arrays of points arranged on a body-centred lattice have been computed according to the D

scattering formula, $I = \sum_i \sum_j (\sin r_{ij}s)/r_{ij}s$ and plotted as a function of $t = as$, where a is the unit translation of the lattice. A.

548.735

8086. The strength of the 10 Å reflexions in haemoglobin. F. H. C. CRICK. *Acta cryst.*, **6**, 600–3 (*July*, 1953).

A method is described for calculating the total intensity of X-ray reflections at spacings near 10 Å that one would expect from models of a protein consisting mainly of α-helices, not necessarily parallel. A comparison with Perutz's observed data for haemoglobin shows that the observed intensity is compatible with such models. The comparison can be made only with moderate accuracy. A.

548.735

8087. X-ray scattering by aggregates of bonded atoms. III. The bond scattering factor: simple methods of approximation in the general case. R. MCWEENY. *Acta cryst.*, **6**, 631–7 (*July*, 1953).

For Pt II, see Abstr. 7314 (1952). General approximate methods of calculating the bond scattering factor (defined in Pt II) are devised: formulae are given which cover all cases arising from bonds involving (1*s*), (2*s*) and (2*p*) electrons. The approximate method is compared with the earlier rigorous method in a treatment of the hydrogen molecule and is found to be entirely adequate. The absolute accuracy of the resultant effective atomic scattering factor (f^e) is carefully investigated, again in the hydrogen-molecule case, by systematic refinement of the wave-function. A change of "effective nuclear charge" in the atomic orbitals employed is found to have a considerable effect on the calculated f^e, but the introduction of a certain amount of configuration interaction (equivalent to the addition of ionic terms) is found to have a very small effect. It is concluded that the original definition of an effective scattering factor (based upon a one-configuration wave-function) is completely satisfactory. More complete knowledge of the parameters in molecular wave-functions is perhaps desirable; but calculations based upon quite crude estimates are likely to yield substantially correct scattering factors since the valence-electron contribution is usually relatively small. On the other hand, attempts to allow for the effect of bonding by empirical methods, using point charges in the bonds, are to be discouraged. A.

548.735.44

8088. A method of Fourier synthesis using a standard Hollerith senior rolling total tabulator. N. KITZ AND B. MARCHINGTON. *Acta cryst.*, **6**, 325–6 (*April*, 1953).

Describes a method of setting up a Hollerith senior rolling total tabulator for the calculation of Fourier synthesis in which the tabulator runs at its maximum tabulating speed and with which no auxiliary Hollerith machinery is required. A.

548.735.44

8089. Locating the principal maxima of a Fourier series. H. HAUPTMAN AND J. KARLE. *Acta cryst.*, **6**, 469–72 (*June*, 1953).

A numerical method for locating the principal maxima of a multi-dimensional Fourier series is described which obviates the necessity for computing the function. The underlying postulate is that the most prominent maxima lie in those regions in which there occurs dense packing of the maxima of the individual terms of the series. The procedure has been adapted for use with I.B.M. equipment. A.

548.735.44

8090. Application of statistical methods to the naphthalene structure. J. KARLE AND H. HAUPTMAN. *Acta cryst.*, **6**, 473–6 (*June*, 1953).

A method for locating the principal maxima of a Fourier series (preceding abstract) was applied to a function describing the probability distribution for interatomic vectors using the data of Abrahams, Robertson and White for naphthalene. A structure comparable to that found by Abrahams *et al.* was obtained. No attempt was, however, made to obtain the ultimate accuracy inherent in this method. A.

548.735.44

8091. Contour lines and the optical representation of two-dimensional Fourier series. G. VON ELLER. *C.R. Acad. Sci.* [*Paris*] **236**, 2159–60 (*June* 1, 1953) *In French.*

A somewhat complicated function of the structure amplitudes of a crystal is obtained, whose Fourier transform, produced optically, will consist of fringes following the contours of equal electron density.

A. R. STOKES

548.735.46

8092. An extension of the "difference Patterson" to facilitate the solution of order-disorder problems. A. J. FRUEH, JR. *Acta cryst.*, **6**, 454–6 (*June*, 1953).

In both the ordered and disordered phases of those minerals based upon close packed anions (chalcopyrite, bornite, stannite, etc.) it is often difficult to locate the specific cation positions from among the symmetrically distributed possible sites. Because of the identity of many of the interatomic distance vectors, the Patterson projections, or sections, of such structures cannot be readily solved. If it can be shown, or assumed, that the non-superstructure, or fundamental, X-ray reflections do not change in intensity when these structures are disordered, then Patterson projections, or sections, made using the superstructure reflections alone, represent vector maps where all the vectors are suppressed except those between like atoms that change position during the disordering process. Positive peaks represent vectors between sites, both of which have gained or both lost in atomic number through disordering. Negative peaks represent vectors between sites where one has gained and the other has lost in atomic number during disordering. Chalcopyrite is used as a known example to show the advantages and shortcomings of the method. A.

548.736.1

8093. The crystal structure of β selenium. R. E. MARSH, L. PAULING AND J. D. MCCULLOUGH. *Acta cryst.*, **6**, 71–5 (*Jan.*, 1953).

The structure reported by Burbank [Abstr. 5444 (1952)] is shown to be in error. From reanalysis of intensity data of the type *hk*0 the Se_8 molecule is shown to be a puckered ring rather than a chain. This ring has approximate symmetry $\bar{8}2m$, as in

α selenium. Satisfactory packing between Se_8 molecules is also obtained with the revised parameters, and there appears to be very little structural difference between α selenium and β selenium. Evidence is presented that a single crystal of β selenium may transform into an aggregate of crystals of hexagonal selenium rather than into a single crystal as proposed by Burbank. A.

548.736.1

8094. Crystal chemical studies of the 5*f*-series of elements. XIX. The crystal structure of the higher thorium hydride, Th_4H_{15}. W. H. ZACHARIASEN. *Acta cryst.*, **6**, 393–5 (*May*, 1953).

For Pt XVIII, see Abstr. 9180 (1952).

548.736.1

8095. The crystallography of the titanium transformation. C. J. MCHARGUE. *Acta cryst.*, **6**, 529–30 (*June*, 1953).

The orientation relationships between hexagonal close packed and body-centred cubic titanium have been found to be $(0001)_{h.c.p.}$ parallel to $(110)_{b.-c.c.}$ and $[11\bar{2}0]_{h.c.p.}$ parallel to $[111]_{b.-c.c.}$. These were determined by noting the relationships between several large α grains which had been formed from a single β grain. These relationships agree with those reported for zirconium and lithium. The habit plane of titanium has been shown to be $(331)_{b.-c.c.}$ within an experimental error of 2°. This was determined from the relief effects present in large α grains and the orientation relationships developed above. A.

548.736.3

8096. The crystal structure of tetraiodoethylene, C_2I_4. T. L. KHOTSYANOVA, A. I. KITAĬGORODSKIĬ AND YU. T. STRUCHKOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 4, 785–8 (1952) *In Russian.*

Using a de Jong and Bouman camera with Mo radiation the unit cell of C_2H_4 was found to be monoclinic, $P2_1/c$, with $a = 15{\cdot}10 \pm 0{\cdot}05$ Å, $B = 4{\cdot}45 \pm 0{\cdot}02$, $c = 13{\cdot}00 \pm 0{\cdot}04$, $\beta = 109° \pm 1°$, $Z_{obs.} = 3{\cdot}80$ and $\rho_{obs.} = 3{\cdot}98$ gm/cm^3. The intensities of 1028 reflections were measured and put on to an absolute scale by a statistical method. The *h*0*l* Patterson projection was solved by the method of inverting maxima in pseudocentres of symmetry [Abstr. 9117 (1950) and 2259 (1952)]. An *h*0*l* Fourier projection with 125 terms gave the x and z co-ordinates of the I atoms. The y co-ordinates were found by three-dimensional series using all 1028 reflections. An algebraic method of refining the y co-ordinates based on the least squares principle was applied. The C atoms were fitted in from geometrical considerations. The 2 independent molecules have their centres at $0\frac{1}{2}0$ and $\frac{1}{2}00$. The 4 I atoms in each are coplanar and form a square of side $3{\cdot}64 \pm 0{\cdot}02$ Å. The planes of the I_4 squares make angles of 27·5° and 28° with the 010 plane. If C = C is assumed to be 1·34 Å, then C–I is 2·15 Å and the angle I–C–I is 115°. A. L. MACKAY

548.736.3

8097. Structure determination of the alloy phases Cu_2Te, CuTe, Cu_3Sb, InTe, Bi_2Se_3, Pd_5Sb_3 and Pd_3Bi_2. K. SCHUBERT, K. ANDERKO, M. KLUGE, H. BEESKOW, M. ILSCHNER, E. DORRE AND P. ESSLINGER. Note in *Naturwissenschaften*, **40**, *No.* 9 269 (1953) *In German.*

Cell dimensions and descriptions of structures are given for each phase. A. R. STOKES

548.736.3 : 538.22

8098. The antiferromagnetic structure deformation in CoO and MnTe. S. GREENWALD. *Acta cryst.*, 396–9 (*May*, 1953).

CoO and MnTe have been studied above and below their antiferromagnetic Curie temperatures with symmetrical back-reflection camera. CoO exhibits a sharp change in lattice constants between 284° and 278°K, and thereafter a more gradual change its transition from cubic to tetragonal symmetry MnTe does not show a structure transition but only a sharp contraction of the hexagonal c axis below the Curie temperature.

548.736

8099. The crystal structure of $BaCd_{11}$. M. SANDERSON AND N. C. BAENZIGER. *Acta cryst.*, 627–31 (*July*, 1953).

The crystal structure of $BaCd_{11}$ (and isotypic $SrCd_{11}$, $CeZn_{11}$, $LaZn_{11}$, $PrZn_{11}$) was determined from Weissenberg diagrams. The unit cell is body-centred tetragonal, $a = 12{\cdot}02$, $c = 7{\cdot}74$ Å for $BaCd_{11}$, $Z = 4$, and the space group is $I4/amd$. The positions of the atoms were determined from electron-density projections on the (001) and (010) planes. The barium atom is surrounded by 22 cadmium neighbours; the cadmium atoms have 12–14 nearest neighbours.

548.736

8100. Anomalous lattice constants of zinc oxide. G. D. ARCHARD. *Acta cryst.*, **6**, 657–60 (*July* 1953).

Samples of zinc oxide examined by X-ray diffraction were found to exhibit (1) axial ratios 1 part in 500 lower than normal, and (2) significant discrepancies in the lattice spacings determined from different reflections. The same samples exhibited abnormal electrical conductivities. With a view to explaining the observations, two hypothetical lattice distortions were considered. It was found that a small change in the nominally 120° angle of the hexagonal cell could be confused with a change in axial ratio, and that changes in the nominally 90° angles together with mutual translations of the atoms could explain the discrepancies in the lattice spacings. Certain samples changed from "regular" to "anomalous" behaviour after exposure to the atmosphere, thus suggesting a possible cause for the phenomenon.

548.73

8101. The structure of PdO. J. WASER, H. A. LEVY AND S. W. PETERSON. *Acta cryst.*, **6**, 661–3 (*July* 1953).

On this basis of neutron and X-ray diffraction data the structure of PdO is confirmed to be based on the space group D^9_{4h}–$P4_2/mmc$ with two PdO per unit cell. The cell dimensions are $a = 3{\cdot}03 \pm 0{\cdot}01$, c $5{\cdot}33 \pm 0{\cdot}02$ Å and the atomic positions are 2Pd at 0, 0, 0; $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{2}$ and 2O at $\frac{1}{2}$, 0, $\frac{1}{4}$; $\frac{1}{2}$, 0, $\frac{3}{4}$.

548.736.3

102. The existence of short range order in solid solutions. A study of aluminium silver alloys. . FOURNET. *C.R. Acad. Sci.* [*Paris*] **237,** 75–7 (*July* 6, 1953) *In French.*

Experimental observations [Abstr. 8491 (1952)] of the intensity I of X-rays scattered from these alloys at low angles θ have provided evidence for clustering of Ag atoms. The observed magnitude of I and its variation with θ, at two different temperatures, are consistent with a degree of order calculated by taking $V(r) = W_{Al-Al}(r) + W_{Ag-Ag}(r) - 2W_{Al-Ag}(r)$ as $-5{\cdot}5\times10^2$ k for 1st neighbours (W_1) and as $-11{\cdot}10^2$ k for second neighbours (W_2), $W_{x-y}(r)$ being the interaction energy between an x and a y atom separated by a distance r. That W_2 is numerically greater than W_1 is also indicated from considerations of the variation of lattice parameter with composition. A. D. LE CLAIRE

548.736.3 : 539.133

8103. The crystal and molecular structure of B_4Cl_4. M. ATOJI AND W. N. LIPSCOMB. *Acta cryst.*, **6,** 547–50 (*June*, 1953).

The molecule B_4Cl_4 consists of a nearly regular tetrahedron of boron atoms surrounded by a larger, nearly regular tetrahedron of chlorine atoms with B–Cl single bonds (1·70 Å) directed away from the centre of the tetrahedra. The molecular symmetry is D_{2d}–$\bar{4}2m$, but differs only slightly from T_d–$\bar{4}3m$, and the average B–B distance is 1·70 Å. Molecular centres are at 0, 0, ½ and ½, ½, 0 in the space group D_{4h}^{15}–$P4_2/nmc$, with $a = b = 8{\cdot}09$ Å and $c = 5{\cdot}45$ Å. A.

548.736.4

8104. The crystal structures of $(Mo, W)_{10}O_{29}$ and $(Mo, W)_{11}O_{32}$. B. BLOMBERG, L. KIHLBORG AND A. MAGNÉLI. *Ark. Kemi*, **6,** *Paper* 11, 133–8 (1953).

In both structures the unit cell is monoclinic, containing two formula units, space-group $P2/a$. Atomic co-ordinates are given. These structures fit into the homologous series Me_nO_{3n-1} [see Abstr. 8060 (1953)]. A. R. STOKES

548.736.4

8105. On the structure of K_2NiF_4. D. BALZ. Note in *Naturwissenschaften*, **40,** *No.* 8, 241 (1953) *In German.*

Tetragonal, $a = 4{\cdot}00$, $c = 13{\cdot}06$ [Å]? $Z = 2$, calculated density 3·37, space group probably D_{4h}^{17} [$I4/mmm$] with 2Ni in (*a*), 4F in (*c*), 4F in (*e*) with $z = 0{\cdot}15$, 4K in (*e*) with $z = 0{\cdot}35$. A. J. C. WILSON

548.736.4

8106. Rare earth titanates with a Perovskite structure. J. BROUS, I. FANKUCHEN AND E. BANKS. *Acta cryst.*, **6,** 67–70 (*Jan.*, 1953).

548.736.4 : 536.424

8107. The persistence of crystal axes in a thermal transformation. S. W. KENNEDY, A. R. UBBELOHDE AND I. WOODWARD. *Proc. Roy. Soc. A*, **219,** 303–11 (*Sept.* 22, 1953).

X-ray measurements on single crystals of KNO_3 are described which test how far the crystal axes persist in a thermal transformation cycle I $\underset{\leftarrow}{\overset{\rightarrow}{128°}}$ II. Though some break-up into disoriented subunits is observed, pseudo-single crystals are generally obtained after a thermal cycle. In moist crystals, the *b*-axis shows a marked persistence with respect to the original *b*-axis. The *a*- and *c*-axes often, but not always, undergo rotation about the original direction of the *b*-axis. The direction of none of the original axes persists in rigorously dried crystals. The observations are discussed with reference to geometric and thermodynamic aspects of the transformation. A.

548.736.5

8108. X-ray structural investigation of the compounds $K_2[Pt(NO_2)_4Cl_2]$ and $K_2[Pt(NO_2)_4Br_2]$. G. B. BOKIĬ AND É. A. GILINSKAYA. *Dokl. Akad. Nauk SSSR*, **88,** *No.* 6, 975–8 (1953) *In Russian.*

From de Jong and Bouman photographs the unit cell dimensions were found to be $a = 9{\cdot}42$, $b = 9{\cdot}47$ and $c = 7{\cdot}40$ kX for the Cl isomer and $a = 9{\cdot}55$, $b = 9{\cdot}50$ and $c = 7{\cdot}33$ kX for the Br isomer. Optical goniometry had shown the crystals to be monoclinic with $\beta = 118°\,41'$ and $120°\,25'$ for the Cl and Br compounds respectively. The space group is $P2_1/a$, $\rho = 3{\cdot}12$ (Cl isomer) and $Z = 2$. The Pt atoms were found to lie at 000 and $\frac{1}{2}\frac{1}{2}0$ and Patterson projections gave the positions of Cl and Br atoms. Fourier projections combined with packing considerations gave the remaining parameters (x, y, z) which, for the Cl isomer, are: K, (0·658, 0·042, 0·319); Cl, (0, 0·113, 0·284); N_I, (−0·035, 0·197, −0·146); N_{II}, (0·253, 0·028, 0·138); O_I, (−0·047, 0·306, −0·061); O_{II}, (−0·047, 0·205, −0·021); O_{III}, (0·329, 0·087, 0·310); O_{IV}, (0·329, −0·015, 0·050). A. L. MACKAY

548.736.5

8109. Preliminary communication on the crystal structure of silver sulphimide $Ag_3(NSO_2)_3 \cdot 3H_2O$. K. R. ANDRESS AND K. FISCHER. Note in *Naturwissenschaften*, **40,** *No.* 8, 240–1 (1953) *In German.*

Hexagonal, $a = 10{\cdot}59 \pm 7$, $c = 5{\cdot}37 \pm 3$ kX, measured density 3·72, $Z = 2$ of the trimeric formula, space group $C6_3/mmc$ from absences and absence of piezoelectricity. From chemical and crystallographic evidence it is concluded that the anion is $N_3S_3O_6^{3-}$, with the N and S alternating at the corners of a plane hexagon. A. J. C. WILSON

548.736.5

8110. The crystal structure of strontium hydroxide octahydrate, $Sr(OH)_2 \cdot 8H_2O$. H. G. SMITH. *Acta cryst.*, **6,** 604–9 (*July*, 1953).

Strontium hydroxide octahydrate, $Sr(OH)_2 \cdot 8H_2O$, is tetragonal and $a_0 = 9{\cdot}00 \pm 0{\cdot}01$, $c_0 = 11{\cdot}58 \pm 0{\cdot}01$ Å. The space group is D_{4h}^8–$P4/ncc$ with four molecules per unit cell. The oxygen atoms of the water molecules occupy two sixteenfold sets of general positions related by a translation ½, ½, 0. Each oxygen atom is hydrogen bonded to at least three other oxygen atoms, using all 72 hydrogens in hydrogen-bond formation. It is impossible to determine whether the strontiums are in the set 0, 0, 0 or 0, 0, ¼ by X-ray diffraction data alone. An argument is presented for placing the strontiums in the set 0, 0, ¼, which results in a square Archimedean antiprism co-ordination of water molecules. A.

548.736.6

8111. Determination of the stoichiometric composition of a substance by means of its X-ray powder diagram: application to a new phosphate of silica. A. Boullé and R. Jary. *C.R. Acad. Sci.* [*Paris*] **237**, 161–3 (*July* 15, 1953) *In French.*

A number of mixtures of phosphoric acid and colloidal silica were heat-treated and the intensities of X-ray diffraction lines from the resulting compounds were compared with those of an internal MgO_2 standard. The results indicate that the ratio $P_2O_5/SiO_2 = 0{\cdot}66$. A. R. STOKES

548.737

8112. Crystal structure of potassium ethyl sulphate. J. A. J. Jarvis. *Acta cryst.*, **6**, 327–30 (*April*, 1953).

The crystal structure of potassium ethyl sulphate has been determined in order to establish whether a bond from sulphur to an oxygen atom which is also bonded to another atom is longer than that to an oxygen atom not so bonded. Crystals of $K(C_2H_5)SO_4$ are monoclinic, space-group $P2_1/c$. The dimensions of the unit cell, which contains 4 molecules, are: $a = 11{\cdot}62$, $b = 6{\cdot}99$, $c = 7{\cdot}51$ Å, $\beta = 100{\cdot}3°$. Atomic co-ordinates were determined by three-dimensional Fourier methods, and corrections for termination-of-series errors were applied for the oxygen and sulphur atoms. Bond lengths in the ethyl sulphate radical are: $S–O_1 = 1{\cdot}49$, $S–O_2 = 1{\cdot}44$, $S–O_3 = 1{\cdot}45$, $S–O_4 = 1{\cdot}60$, $O_4–C_1 = 1{\cdot}44$, $C_1–2_2 = 1{\cdot}51$ Å. The bond between S and O_4 is significantly longer than that to the other O's, which are bonded to S only. Each K ion is surrounded by eight O atoms at distances ranging from 2·80 to 3·02 Å. A.

548.737

8113. The structure of crystalline chromous acetate revealing paired chromium atoms. J. N. van Niekerk, F. R. L. Schoening and J. F. de Wet. *Acta cryst.*, **6**, 501–4 (*June*, 1953).

Crystals of chromous acetate are monoclinic with space group $C2/c$. The unit cell, of dimensions $a = 13{\cdot}15$, $b = 8{\cdot}55$, $c = 13{\cdot}94$ Å, $\beta = 117° 0'$, contains four $Cr_2(CH_3COO)_4 . 2H_2O$ molecules. Projections of the structure on two crystallographic planes are given and from these it is inferred that chromous and cupric acetate are isostructural. The most striking feature of the structure is the close approach of 2·64 Å between the two chromium atoms in a molecule, which, as in the case of the cupric acetate structure, suggests direct interaction between such atoms. A.

548.737

8114. The electron distribution in crystalline α-pyridone. B. R. Penfold. *Acta cryst.*, **6**, 591–600 (*July*, 1953).

The electron density in crystals of α-pyridone has been measured with sufficient accuracy in two projections to establish the existence of the molecule in the pyridone form which differs from its tautomer, the hydroxy form, only in the position of one hydrogen atom. The molecular electron density is satisfactorily explained within the experimental error by an assemblage of isolated atoms, each with its own temperature factor, and possessing the electron distribution calculated by McWeeny using analytical approx mations to atomic wave-functions. Bond leng have been measured with a standard deviation 0·010 Å and can be explained in terms of a resona structure in which polar forms of the molecule p an important part. The hydrogen atom respons for tautomerism is concerned in an intermolecu N–O hydrogen bond, which, repeated throughout t structure, links molecules into endless helices.

548.737 : 539.

8115. The crystal and molecular structure of 1 dichloroethane at −140°C. T. B. Reed and W. Lipscomb. *Acta cryst.*, **6**, 45–8 (*Jan.*, 1953).

548

8116. Neutron diffraction studies of magnes ferrite-aluminate powders. G. E. Bacon and F. Roberts. *Acta cryst.*, **6**, 57–62 (*Jan.*, 1953).

Neutron diffraction measurements with magnesi ferrite aluminates support the suggestion of Jones Roberts that all the Al^{3+} ions in these compounds into *B* sites. The neutron data are able to distingu between the Mg^{2+} and Al^{3+} ions, and are sensi to the value of the oxygen parameter *u*. The val of *u* deduced for $MgFe_2O_4$ and $MgFeAlO_4$ $0{\cdot}382 \pm 0{\cdot}002$ and $0{\cdot}385 \pm 0{\cdot}002$ respectively.

548

8117. Stacking faults in γ-alumina. J. M. Cowl *Acta cryst.*, **6**, 53–4 (*Jan.*, 1953).

Extra spots and line segments observed in sin crystal electron-diffraction patterns of γ-alum are interpreted in terms of faults in the cubic cl packed stacking of the oxygen atoms. Near the f planes some aluminium atom sites are "unfavourab in that they are nearer than usual to other alumin sites. It is suggested that the vacant aluminium s in γ-alumina occur preferentially at such " favourable" positions along fault planes.

54

8118. Structure analysis of single crystals by elect diffraction. I. Techniques. J. M. Cowley. *A cryst.*, **6**, 516–21 (*June*, 1953).

The possibility of using single-crystal elect diffraction patterns from very small crystals structure analysis by Fourier methods is discus It is pointed out that the crystals used must be more than a few hundred Ångström units thick order to avoid modification of the intensities of reflections by dynamic interaction or secon diffraction. The principal experimental difficu are the manipulation of the specimen and the meas ment of the intensities. A new method of inten measurement, involving the photographic recor of spots spread out by periodic potentials applie a set of deflecting plates, is described and illustra The interpretation of Fourier projections of potential distribution in a crystal is considered.

54

8119. Structure analysis of single crystals by elec diffraction. II. Disordered boric acid struct J. M. Cowley. *Acta cryst.*, **6**, 522–9 (*June*, 1953).

The techniques of structure analysis using sin crystal electron-diffraction patterns have been app to the study of very small boric acid crystals in wh

here is almost complete disorder in the stacking of the two-dimensional layers of atoms. The structure of the layers and the nature of the order present are derived by a method involving a "distribution function" which defines the distribution in space of equivalent points in the layers. The hydrogen ions in the hydrogen bonds are shown to have their most probable positions approximately 1 Å from an oxygen atom. An apparent interaction between parallel hydrogen bonds is observed. Suggestions are made for the further application of the distribution-function method. A.

GEOPHYSICS 55

550.384 : 551.510.535

8120. The conductivity of the ionosphere and geomagnetic variations. I. Lucas. Note in *Naturwissenschaften*, **40**, *No.* 5, 239 (1953) *In German.*

Outlines an explanation for the large lunar magnetic variations observed at stations near the magnetic equator and also for the narrow zone of high conductivity (about ±7° wide) about this equator.

W. J. G. BEYNON

550.42

8121. On the concentration of certain elements at the earth's surface. H. C. Urey. *Proc. Roy. Soc. A*, **219**, 281–92 (*Sept.* 22, 1953).

A survey of the abundances of elements in the ocean and sedimentary rocks as compared to their abundances in the weathered igneous rocks shows that carbon, nitrogen, oxygen as water, chlorine, bromine and boron are highly concentrated in the surface materials and that thicknesses of from 17 to 89 km of the outer part of the earth would be required to produce these elements if all of them now present in the igneous rocks were removed. A study of the available information indicates that many other elements would be concentrated at the earth's surface if chlorine, bromine and boron were concentrated there by a high-temperature volatilization process either from volcanoes or in an original high-temperature atmosphere of the earth. It is concluded that the removal of these elements from the outer parts of the earth occurred through solution in water at low or moderate temperatures (~100°C or less), since they are soluble and other elements are not. Iodine should belong to this group, but its position is uncertain because of doubtful analytical data. Sulphur may belong in some degree with the volatiles, i.e. carbon as methane or carbon dioxide, nitrogen as ammonia or molecular nitrogen, and water. It is shown that the low abundances of mercury and arsenic in the sediments are inconsistent with a temperature of formation of the earth's surface regions higher than a few hundred degrees centigrade. The presence of appreciable quantities of nitrogen in the igneous rocks indicates that this element was present in condensed phases during the earth's formation, and a survey of the conditions of stability of such compounds indicates temperatures of about 200°C or less. It has not been possible to decide whether liquid water was present on the primitive earth. A.

ATMOSPHERE . METEOROLOGY 551.5

551.508.11

8122. Radiosounding of wind by impulses without responder. J. Lugeon. *C.R. Acad. Sci.* [*Paris*] **236**, 2426–8 (*June* 22, 1953) *In French.*

A method is described by which the expensive responder used in a radiosonde for wind finding can be eliminated. Short-wave impulses of short duration transmitted from the ground are received directly on the transmitting aerial of the radiosonde which acts then as a receiver. The transmitter of the radiosonde also emits short impulses with a frequency near to that for the ground and in the breaks it acts as a receiver and interrupts the next signal. This interruption is maintained stable. The distance of the balloon from the ground is given from the echo method by the time interval between sending and receiving the signal. This method replaces others such as triangulation, radio theodolite or true radar and gives precise measurements for strong winds at great heights and distances. The method is called "echosondage." R. S. READ

551.508.7

8123. Method of collection and observation of atmospheric powders without modification of their state of agglomeration. L. Le Bouffant. Letter in *J. Phys. Radium*, **14**, 425–6 (*June*, 1953) *In French.*

The aerosol is filtered through a cellulose membrane with pores less than 0·2 μ. The density of deposition is kept so low that false aggregates are negligible, and the deposit is prepared for microscopic examination by impregnation with a mixture of cedar oil and amyl acetate. J. M. HOUGH

551.510.5

8124. Air motion in the upper atmosphere. R. S. Scorer. *Nature* [*London*] **171**, 138–9 (*July* 25, 1953).

The properties and motion of the air above the tropopause are examined. Ozone measurements show a maximum temperature around 50 km and a minimum around 80 km. The dynamical properties of the layer between the tropopause and the ionosphere are probably similar to those in the troposphere, but the diurnal variations are dominant and convection of the atmosphere is similar to the cyclone and cumulus types but of much greater size. The actual temperature at any place and time probably differs greatly from the average and it is the variations which are associated with the dynamical processes. Probably a vigorous exchange of air takes place between the ozonosphere and the *E* layer, and observations on the *E* layer of the size, diurnal variation and movement of irregularities may help to show the connection between them and air movements. R. S. READ

551.510.535

8125. Wave hypothesis of moving irregularities in the ionosphere. C. O. Hines. Letter in *Nature* [*London*] **171**, 980 (*May* 30, 1953).

Note on theoretical examination of magneto-

hydrodynamic effects involved in a wave-hypothesis of ionospheric "winds." It is found that travelling atmospheric disturbances can, under special resonant conditions, become large, and simplified expressions for the quasi-period and group speed are given. When applied to typical $F2$ disturbances observed by Munro [Abstr. 7632 (1950)] these lead to a satisfactory estimate of temperature (~1000°K) and a specific heat ratio (~1·1) lower than usual, in accordance with Martyn's result [Abstr. 4532 (1950)].

G. M. BROWN

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 7807–8

551.510.536 : 521.1

8126. Upper wind and Kepler motion. H. QUIRING. Note in *Z. Naturforsch.*, **8a**, 395–6 (*June*, 1953) *In German.*

The similarity of the motion of the cloud canopy on Jupiter's surface, the levels above the solar surface and the earth's atmosphere up to great heights leads to the conclusion that all follow Kepler's three laws. At 860–1000 km above the earth the H and He atoms very probably follow a Kepler path and are held there by gravitation and centrifugal acceleration. It is considered this theory is more plausible than that of a thermally regulated atomic movement. At the equator at these heights the H and He atoms have a Kepler movement of 7·64–7·36 km/sec. R. S. READ

551.513 : 536.25 : 532.51

The forced flow of a rotating viscous liquid which is heated from below. *See Abstr.* 7485

551.524.7

8127. High-altitude diurnal temperature changes due to ozone absorption. F. S. JOHNSON. *Bull. Amer. Meteorol. Soc.*, **34**, 106–10 (*March*, 1953).

The heating effect due to absorption of solar energy by atmospheric ozone was calculated from direct measurements of ozone concentrations and of the ultraviolet spectral intensity of sunlight made during a rocket flight over New Mexico on June 14, 1949. Assuming a constant rate of heat loss throughout the day and night due to infrared emission, and no temperature change from day to day, the diurnal temperature change was found to have maximum value of 5·3°c at 48 km, falling to 1°c at 31 km and 70 km. A.

551.578.1

8128. The effect of relative humidity on the nucleating properties of photolyzed silver iodide. S. J. BIRSTEIN. *Bull. Amer. Meteorol. Soc.*, **33**, 431–4 (*Dec.*, 1952).

The effect of relative humidity on the photolysis and subsequent nucleating properties of silver iodide particles has been studied. Known amounts of water vapour were introduced into a stream of nitrogen passing over a silver iodide generator. The silver iodide particles, covered with adsorbed water, were collected in a cell and exposed to ultraviolet light of known intensity for varying amounts of time. After irradiation, the particles were injected into a cloud of supercooled water droplets and ice formation was watched for. The nucleating effectiveness of silver iodide exposed to ultraviolet light was found to be directly dependent on the relative humidity of the stream passing over the generator. See also Abs 5940, 7350 (1951), 8600 (1952).

551.593

8129. Atmospheric turbidity and a twilight anoma C. HOFFMEISTER. Letter in *Naturwissenschaften*, *No.* 12, 335–6 (1953) *In German.*

A brief description of a twilight phenomenon se in S. Africa, April, 1953. A strengthening of normal twilight glow is attributed to a strong reflecting layer of dust extending to an estima height of 16 km whose structure was variable fr day to day. D. R. BARR

551.59

8130. An artifice for the immediate perception of polarization of the light of the sky. E. WÖHLISC Note in *Naturwissenschaften*, **40**, *No.* 8, 238 (19 *In German.*

Persons who find it difficult to see Haidinge brushes may find it easier by turning the head and fro through 90° while looking at the sky. T imitates the effect of a nicol prism: the axis of yellow brushes points toward the sun, whereas t of the blue ones corresponds to the direction polarization. The turning of the head increases effect by contrast. R. A. WE

551.59

8131. Intensity of the ^4S–^2D line of atomic nitrog at twilight. M. DUFAY. *C.R. Acad. Sci.* [*Paris*] **22** 2160–1 (*June* 1, 1953) *In French.*

A study of the twilight emission of N at 5199 and a comparison of its intensity with that of O 5577 Å indicate a mean intensity for the N emissi of $c\,1{\cdot}5\times10^7$ quanta cm^{-2} sec^{-1} vertical cross-secti of atmosphere. This result is discussed in relation excitation by fluorescence. The N emission is correlated with geomagnetic disturbance. D. R. BARR

551.593.9 : 537.5

8132. Light pulses from the night sky. J. V. JEL AND W. GALBRAITH. *Phil. Mag.*, **44**, 619–22 (*Ju* 1953).

See Abstr. 4513 (1953). Further experimen results are reported on the phenomenon of li pulses from the night sky associated with cosmic ra The relative frequency of discharge of G.M. count with distance from the light receiver, comprising photomultiplier and a parabolic mirror, has be investigated. The differential height distribution light pulses has been found to be exponential in for and the intensity of those pulses detected at the r of about 1 per minute is, very approximate 3 photons per cm^2 per pulse.

551.594

8133. Observations on the impurities in free a H. GARRIGUE. *C.R. Acad. Sci.* [*Paris*] **236**, 2309- (*June* 15, 1953) *In French.*

Results of analysis of atmospheric radioactiv and pollution from measurements on free air and atm. precipitation (snow) at heights from grou level to the summit of the Puy de Dôme (1450 during January–February, 1953. The radioactivity v

obably of distant origin (from nuclear fission xplosions); the dust and soot of local origin.

A. O. STANESBY

551.594.2

8134. Thunderstorm-precipitation growth and electrical-charge generation. S. E. REYNOLDS. *Bull. mer. Meteorol. Soc.*, **34**, 117–23 (*March*, 1953).

It is shown, by use of Langmuir's precipitation rowth data and Ludlam's hailstone heat economy ata, that the glaze-ice thunderstorm charge genera- on mechanism suggested by Workman and the uthor [Abstr. 5802 (1950)] is consistent with the hunderstorm cell development pattern observed. he environment of charge separation is found heoretically. It is also shown that the initiation of precipitation in Midwestern thunderstorms without he involvement of ice crystals is consistent with angmuir's cloud-droplet growth theory. A.

551.594.5 : 523.746

Information concerning the 80-year sunspot cycle in ancient auroral observations. *See Abstr.* 7400

551.594.6 : 621.396.821

8135. An investigation of whistling atmospherics. L. R. O. STOREY. *Phil. Trans A*, **246**, *No.* 908, 113–41 (1953).

Experimental study of "whistlers" (i.e. atmospherics observed at frequencies below 15 kc/s giving a characteristic whistling tone of descending pitch) and their association with "click" type atmospherics. The whistlers were recorded on magnetic tape and analysed on the sound spectrograph. The law of variation of their frequency with time was determined, and also their diurnal and annual variations and association with magnetic activity. A theory is developed that whistlers are due to waves which originate in normal impulsive atmospherics and travel through the outer ionosphere following the lines of force of the earth's magnetic field. The electron densities required at very great heights in the atmosphere are rather large, demanding either a temperature as high as 7200°K for the outer ionosphere or an extra-terrestrial electron source, such as solar corpuscular streams. G. M. BROWN

BIOLOGY 57/59

578.08 : 591.181 : 591.12

8136. An animal respirator for use in electrically shielded rooms. K. G. WING AND O. E. DENGLER. *Rev. sci. Instrum.*, **24**, 521–2 (*July*, 1953).

A portable respirator is described which operates with a sufficiently low level of noise and electrical disturbance to permit its use with sensitive electronic equipment in electrophysiological studies of the auditory and other systems. It is operated by a plastic shaft passing through the wall of an electrically shielded room to a portable driving mechanism outside. It may be used with room air or other gases without admixture of room air. Respiratory minute volume is fixed for each animal by adjusting the stroke length of the pump and selecting a suitable drive speed. The animal may be placed in any position for access to any part of its body. Dead-space air and rebreathing are determined by the design and timing of a 3-way valve and by the length of tubing from pump to animal. A.

578.088 : 534.321.9

8137. The application of high-frequency sound waves to the processing of plasma. R. A. RUTBERG. *Dokl. Akad. Nauk SSSR*, **89**, *No.* 2, 265–7 (1953) *In Russian.*

Describes the use of a magnetostriction oscillator to prevent the formation of fibrine clots. J. M. HOUGH

578.088.5

8138. Irradiation of parts of individual cells. R. E. ZIRKLE AND W. BLOOM. *Science*, **117**, 487–93 (*May* 8, 1953).

The irradiation is by protons from a Van de Graaff generator. A variable micro-aperture collimates the beam towards a "bombardment assembly" which includes microscopic focusing devices capable of directing the micro-beam on to the cell concerned to better than 0·6 μ. All mechanical parts are described with clear diagrams. Pre- and post-irradiation ciné-photography records the behaviour of the cell. Observations to date have mostly concerned cells irradiated in various phases of mitosis. Results are discussed and plates given from the photographic records. D. V. MABBS

578.088.5

8139. Radiations and living cells. F. G. SPEAR. *London: Chapman and Hall.* xii + 222 *pp.*

Review in *Brit. J. appl. Phys.*, **4**, 254 (*Aug.*, 1953).

578.088.7

8140. An instrument for the production of micro-electrodes used in electrophysiological studies. J. T. ALEXANDER AND W. L. NASTUK. *Rev. sci. Instrum.*, **24**, 528–31 (*July*, 1953).

The membrane potential of single muscle fibres may be measured using an internal microelectrode of tip diameter less than 0·5 μ. Previously such micro-electrodes could only be prepared manually and this method has certain disadvantages. The problem has been overcome through the use of an instrument for which details of design, construction and operation are given. In principle, a 35 mm length of Pyrex tubing of outside diameter 2 mm and inside diameter 1·3 mm is heated from a surrounding electrically energized platinum coil. At the start, 100 g force is applied to the tubing in the longitudinal direction by means of a solenoid and plunger arrangement. As the tubing softens its length is extended by 5 mm whereupon the automatic application of 1700 g force draws the tubing apart, thus forming two micro-pipettes. The dimensions and electrolytic resistance of typical microelectrodes manufactured with the aid of the instrument are presented. A.

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.84

8141. Properties of the eye with respect to polarized light. H. De Vries, A. Spoor and R. Jielof. *Physica*, **19**, 419–32 (*May*, 1953).

Properties of human as well as insect eyes are discussed that are (or may be) related to more or less complete orientation of absorbing molecules. In the vertebrate retina the molecules of the photochemical substances are orientated at random, but perpendicularly to the axis of the sense cell. Even bleaching by polarized light does not induce a dichroism for light travelling in the direction of the axis. A nearly complete parallel orientation of the molecules in the sense cells of the insect eye could account for their ability to detect the plane of polarization of polarized light. At present this seems to be the only explanation which is compatible with the experiments. Some new measurements on insect eyes are mentioned. It was suggested by Helmholtz that a radially symmetrical orientation of the molecules of the yellow macular pigment in the human eye could explain the phenomenon of the Haidinger brushes. A method is described by which this dichroism can be measured quantitatively. Its spectral distribution is found to be identical with the absorption curve of the pigment and the degree of orientation of the molecules does not exceed about 5%. The same method also enables a study of the double refraction of the ocular media, discovered by Boehm. A.

612.841

8142. The light absorption of the crystalline lens in the infrared. J. Lenoble. *C.R. Acad. Sci.* [*Paris*] **236**, 2539–41 (*June* 29, 1953) *In French.*

The light absorption of six rabbit lenses has been measured between 0·95 and 2·4 μ by placing each lens in turn between two quartz plates in front of a monochromator slit: the resultant slight compression is said to have made no measurable difference. The data follow the absorption characteristics of distilled water between 0·95 and 2·0 μ but rise well above these at longer wavelengths. A table is given.

R. A. WEALE

612.843.2 : 537.531

8143. Concerning the sensitivity of the human retina to X-rays. H. Bornschein, R. Pape and J. Zakovsky. Note in *Naturwissenschaften*, **40**, *No.* 8, 251 (1953) *In German.*

It is known that a dark-adapted eye experiences light when exposed to minute doses of X-rays, though no quantitative results have been available. A table is given showing the threshold dosage rates required to produce the sensation for various human eyes, normal and otherwise, with X-rays of wavelength 0·4 Å. Likely mechanisms are discussed, and it is shown that the number of quanta required is of the same order for light as for X-rays. D. V. MABBS

612.843.31

8144. Spectral sensitivity of the fovea. II. Dependence on chromatic adaptation. D. Jameson and L. M. Hurvich. *J. Opt. Soc. Amer.*, **43**, 552–9 (*July*, 1953).

For Pt I, see Abstr. 5818 (1953). The dependence of the foveal luminosity function on chromat adaptation is investigated in these experimen Results are compared for 5 different states of adapt tion. The adapting fields were a chromatically neutr white and four chromatic fields perceptually uniq in hue: blue, green, yellow and red. The adapti luminance was the same in all cases (=10 mL). H each adaptation, ten threshold sensitivity functic were measured at every 10 mμ from 410 mμ to 700 m for each of two observers. The spectral sensitiv function is shown to undergo small, but regular a consistent changes with changes in chromatic adap tion. The theoretical implications of these resu are discussed.

612.843.6

8145. Light sensitivity and form perception in da adaptation. W. R. Miles. *J. Opt. Soc. Amer.*, 560–6 (*July*, 1953).

The problem of designing and standardizing te of scotopic vision for military purposes has claim much attention. The light sensitivity tests (used studies of avitaminosis) were discarded in the ea 40's in favour of form perception tests for the arm forces, but the relation of the two types of te remains a matter of scientific interest. By means a supplementary form-target device designed for in the Hecht–Shlaer (research) adaptometer, d were collected on trained adult subjects for both li and form thresholds with 3° targets. Results presented and analysed for dark-adapted cone vis and rod vision, separately. Data are given show the differing amounts and character of luminan necessary for cones and rods and for light *v.* percept of form (*T*) orientation. The close correspondence these experimental findings to some results of recen released military research is shown, and the relat of these results to current visual theory on the stimu characteristics of the retina are discussed.

612.843.

8146. Conspicuity of steady and flashing li signals: variation of contrast. S. J. Gerathewo *J. Opt. Soc. Amer.*, **43**, 567–71 (*July*, 1953).

In the past, two measures have been used to expr the comparative effectiveness of steady and flash light signals. These are comparative intensi (*a*) required for threshold, and (*b*) required for eq apparent brightness above threshold. The measures agree in showing that the effectiveness flashing signals is less than that of steady signals, w the intensity of the light phases of the flashing sig equals the intensity of the steady signal. The pres study compares steady and flashing light signals v respect to conspicuity, defined as the speed of respo to a signal above threshold. For large signal c trasts the conspicuity of steady and flashing signa approximately equal. For small contrasts the c spicuity of flashing signals is considerably grea These results suggest that flashing rather than ste signals be used for warning purposes.

612.843.

8147. Metacontrast. M. Alpern. *J. Opt. Amer.*, **43**, 648–57 (*Aug.*, 1953).

The brightness of a flash of light is reduced w it is followed by a second flash in an adjacent reg of the field. This effect, metacontrast, depends up

ong other things, the luminance, duration, posure asynchrony, spatial separation of the two shes, and the region of the field in which the flashes pear. These variables have been systematically vestigated in the present study. The results indicated at the magnitude of the effect increased as the minance or duration of the second flash increased, the luminance or duration of the first flash creased, and as the angular separation of the two shes in space decreased. If the two flashes were nfined to the two-degree centre of the visual field, e effect disappeared, but as they were moved adually out into the peripheral field the effect ickly appeared. Theoretical considerations imply at the effect is explicable as the result of: (*a*) the teraction of two neural events, or (*b*) the interaction the neural events produced by the first flash and e extraneural (electrical?) events produced by the cond flash. Available evidence does not allow a nclusive choice between these two alternatives, but e second hypothesis gives a more satisfactory planation for the delay between flashes required r maximum metacontrast. A.

612.843.721

48. The stereoptometer—a simple haploscopic strument for the study of binocular space perception. A. Alluisi and G. S. Harker. *Science*, **117**, 682–3 *une* 19, 1953).

No experimental result is reported in this descrip- on (2 figs.) of an instrument made from two USAF flex gun sights. It can be used for two types of nge-finding, one of which corresponds to the easurement of stereoscopic acuity and the other to at of interocular vernier acuity. The disadvantage the present model is its lack of symmetry: this is w being remedied. R. A. WEALE

612.85

149. Contribution to a scientific basis of single-annel sound transmission. III. P. Burkowitz. *unk u. Ton*, **7**, 241–9 (*May*, 1953) *In German.*

For Pt II, see Abstr. 5824 (1953). The expressions erived in Pt II are collected together. The principal ctors of hearing, based on single channel reception nd transmission, are discussed: (1) sound intensity tio; (2) time difference; (3) relation between sound tensity and propagation time difference. An xpression is derived for "physiological reverberation me." A. B. WOOD

614.898

8150. Maximum permissible amounts of radio-isotopes in the human body and maximum permissible concentrations in air and water. *Handb. Nat. Bur. Stand., No.* 52, 45 *pp.* (1953).

The extent of the hazard of ingested radioisotopes depends mainly on the initial retention by the body, the fraction going to critical body tissue, and the decay period of the isotope. General equations to include these factors are given for the maximum permissible concentrations of radioactive fluids for continuous immersion (air or water), and for the quantities of radioisotopes to give specific internal exposures. A detailed table gives values of the factors in these equations for all isotopes of current interest. Further tables show evaluations of the equations for most radioisotopes, and concentrations in the body organs which they affect. Values are based on the most up-to-date experimental sources. D. V. MABBS

614.898

8151. Influence of β-mercaptoethylamine and thymus extract on the survival of guinea-pigs irradiated with X-rays. C.-M. Gros and J. Comsa. *C.R. Acad. Sci. [Paris]* **236**, 1611–13 (*April* 20, 1953) *In French.*

Groups of guinea-pigs are identically fed and given whole-body irradiation of 800 r (160 kV X-rays). One group receives β-mercaptoethylamine intra-peritoneally before irradiation, a second, extract of thymus subcutaneously after irradiation, and a third group receives both these treatments. Mortality is reduced to about a half in the two former cases, and to a quarter for the combined treatment. Research on the mechanism is going on. D. V. MABBS

614.898

8152. Summarized proceedings of a meeting on radiation protection—London, January 1953. E. E. Smith. *Brit. J. appl. Phys.*, **4**, 234–8 (*Aug.*, 1953).

A joint meeting of the Industrial Radiology Group of The Institute of Physics and the Hospital Physicists' Association, January, 1953. The papers presented and the discussion on them are summarized; they were concerned with radiation protection, medical and industrial aspects of the subject and methods of personnel monitoring. A.

614.898 : 541.182.3 : 539.16

Properties, maximum doses and intensity measurements of aerosols with an α radioactivity. *See Abstr.* 7856

TECHNICAL MATERIALS 66/67

66

153. Materials. G. E. Evans. *Nucleonics*, **11**, 8–26 (*June*, 1953).

The suitability of various metals, as structural naterials in nuclear reactors, is discussed and relevant hysical and nuclear properties are tabulated. Nuclear properties of moderating materials and some hysical properties of certain shielding concretes are lso listed. An extensive bibliography is given.

L. R. SHEPHERD

666 : 539.23

154. Transition layers on glass surfaces and their relation to alkali content. P. P. Sutton and A. D. Indyk and W. W. Kriegel. Letter in *J. chem. Phys.*, **21**, 1313–14 (*July*, 1953).

669

8155. Properties of beryllium. M. C. Udy, H. L. Shaw and F. W. Boulger. *Nucleonics*, **11**, 52–5 (*May*, 1953).

The atomic, nuclear, general physical, mechanical, chemical and corrosion properties of Be are tabulated and described. The principal methods of extracting the metal from its ores and fabricating it, are outlined. Some of the present and future applications of Be are mentioned. L. R. SHEPHERD

PHOTOGRAPHY 77

77.023

8156. The effect of multiple internal reflections on the densities of half-tone prints on paper. F. R. CLAPPER AND J. A. C. YULE. *J. Opt. Soc. Amer.*, **43**, 600–3 (*July*, 1953).

The equation relating dot area to half-tone density, when sideways scattering of light takes place in the paper, has been modified to take into account multiple internal reflections. Curves showing the relationship between dot area and density for various ink densities and amounts of first-surface reflectance are given. Callahan's conclusion that these effects are negligible is not in accordance with the authors' experience, and the new equations indicate the possibility of densities much higher than the limiting values derived from Callahan's equations and from their earlier equation which neglected multiple internal reflectance. A.

771.35

8157. A new approach to the evaluation of the performance of photographic lenses. F. G. BACK. *J. Opt. Soc. Amer.*, **43**, 685–9 (*Aug.*, 1953).

Lens performance evaluation in terms of resolving power has proved unsatisfactory. The concept of definition has therefore been introduced combining contrast with resolving power. A new method of lens evaluation will be described which takes all factors of image definition into consideration and relates them to the speed of the lens. A.

771.53

8158. Investigations into the Callier effect. I. R. GÖRISCH. *Z. wiss. Photogr.*, **48**, *No.* 4–6, 85–102 (1953) *In German.*

Measurements were made of the blackening S of films with reference to the aperture A of the lens system illuminating the sample, and the aperture B of the lens system projecting the transmitted light on to the measuring photocell. In general the curve of S *v.* A for a fixed value of B shows a max. when $A = B$. The max. values of S increase with decrease of B, while the family of curves for different values of B coincide when A is large. S is a min. when A is a max., which is equivalent to diffuse illumination of the sample. Similar curves were found for S *v.* B with constant A, and for S *v.* A at different levels of blackening and various film types. S increases somewhat if measured by light of longer wavelengths. The Callier factor, or ratio of blackening measured by a directed beam to that measured by diffuse light, is not constant. For a parallel beam it increases with decreasing aperture B, with a steeper rise for coarser emulsions. If $A = B$ the factor decreases with increasing S. S. T. HENDERSON

771.53

8159. Grain size in Ilford G5 emulsions. E. PICKUP. *Canad. J. Phys.*, **31**, 898–900 (*July*, 1953).

Determinations of grain size in unprocessed and processed emulsions, with electron microscope photographs. S. T. HENDERSON

771.

8160. The equation of the characteristic curve photographic emulsions. I. M. GREEN. *Appl. Sp trosc.*, **7**, 24–32 (*Feb.*, 1953).

From measurements at the spectrographic leve illumination it is shown that for exposures of ec time, $\log D_s/D = (I_{10}/I)^n$ where D_s, I_{10} and n constants. Similarly for equal intensity exposu $\log D_s/D = (t_{10}/t)^q$. Hence the equation to characteristic curve, $\log D_s/D = (I_{10}/I)^n . (t_{10}$ Schwarzschild's coefficient $p = q/n$. The values D_s, n, and the max. slope (γ) are given for th emulsions, with different developers and for diffe wavelengths of light. The equation is a good appr mation for one emulsion, and gives accurate agreen for the other two. S. T. HENDER

771

8161. On the fading effect in nuclear plates. HÄLG AND L. JENNY. *Helv. phys. Acta*, **25**, *No* 773–4 (1953) *In German.*

Following on earlier work by the authors [Al 4845 (1952)] and Schopper, Magun and Bl [Abstr. 696 (1952)], it was found that undevelo nuclear tracks fade with two time constants, that fading is increased by exposure to water and hydr peroxide vapour, and that stabilized emulsions better than simple ones. F. R. H

771

8162. Experiments on the reduction of crystal silver bromide. H. D. KEITH AND J. W. MITCH *Phil. Mag.*, **44**, 877–99 (*Aug.*, 1953).

Crystals of silver bromide in the form of sheets with plane parallel surfaces have been red to metallic silver by a variety of methods. Be reduction, they were treated with bromine to des all traces of chemical fog on the surfaces and were not again exposed to actinic light to form e a surface or an internal latent image. Reductio photographic developers was initiated at a lin number of centres on the surface and resulted in production of masses of silver with one of the follo characteristic forms: (1) compact masses of coh micro-crystals of silver occupying cavities bou by (111) surfaces of the silver bromide cry (2) rigid projections based upon such masses consisting of agglomerates of micro-crystals of s what smaller dimensions; and (3) loosely ta bundles of micro-crystals linked by ribbon filaments of silver. The conditions under w silver is produced in these different forms are outl A series of model experiments is described w provides evidence on the mechanisms of reduc The complexity of the problem is emphasized.

77

8163. Reflection electron radiography combined autoradiography—application to the study of r active minerals. J. J. TRILLAT AND L. TER *J. Chim. phys.*, **50**, 215–17 (*April*, 1953) *In Frenc*

A cassette is described for mounting pol specimens of naturally radioactive minerals pitchblend) in contact with photographic

adiation by 200 kV X-rays produces a reflected ctron image of the surface, gradations of blackening curring with atomic numbers of elements present. mparison of these pictures with autoradiographs the same sample show the correlation between nes of radioactivity and the zones of atomic number the electron radiograph. D. V. MABBS

778.34

64. A statistical analysis of grain counting in otographic emulsions. W. W. HAPP, T. E. HULL ID A. H. MORRISH. *Canad. J. Phys.*, **30**, 699–714 *lov.*, 1952).

Fluctuations in the grain density of tracks of arged particles passing through photographic nulsions are examined in terms of the physical operties of grains and the type of counting con- ntion used. A mathematical model for one unting convention which takes into account both the equency distribution of the grains and the frequency stribution of their lengths, yields numerical results good agreement with experimental data. Other atistical problems of interest in grain counting are scussed. A.

778.34

165. Study of radon absorbed in microcrystals of lver halides in nuclear research emulsions. L. IGNERON, R. CHASTEL AND J. GÉNIN. *C.R. Acad. ci.* [*Paris*] **236**, 2053–5 (*May* 27, 1953) *In French.*

The absorption of radon in microcrystals of silver alide is demonstrated by impregnating an Ilford C2 nulsion with radium, which is removed 48 hours ter by prolonged washing. 90% of the radioactivity f the plate after this treatment is shown to be due radon absorbed by the silver halide grains. A mparison of the observed half life of this portion f the radioactivity of the plate, 3·6 days, with the alf life of radon, 3·82 days shows that the rate of iffusion of radon out of the silver halide grains is mall. A. C. COATES

778.34

166. Construction of an apparatus for the detailed vestigation of nuclear tracks of all densities. L. VAN OSSUM. *C.R. Acad. Sci.* [*Paris*] **236**, 2234–6 (*June* 8, 953) *In French.*

A brief description is given of an improved photo- lectric apparatus which is capable of measuring everal characteristics of the tracks of particles ecorded in nuclear emulsions, including the number f isolated grains, the number and length of gaps and f clumps of grains, the width of the track and the umber and lengths of delta rays. The microscope sed in the instrument has a tilting stage which enables hose tracks inclined at an angle to the plane of the mulsion to be orientated into the plane of the micro- cope, thus eliminating the usual corrections for the ngle of dip. A. C. COATES

778.34

167. The grain density and the process of track ormation in nuclear emulsions. I. Grain density and leveloping factor. M. DELLA CORTE, M. RAMAT AND . RONCHI, JR. *Nuovo Cimento*, **10**, 509–25 (*May*, 953).

A critical survey of various methods employed for rain density measurements is given, and a new scheme for the process of track formation is proposed. According to this scheme, which takes into account a process of induced development, grain density for a given emulsion appears to depend on two main factors, namely, the probability that a grain be impressioned, which is obviously directly related to the energy loss, and what is called the "developing factor" K, which is characteristic of the degree of development of the plate. Both these factors can be easily determined experimentally. A series of measurements along tracks due to particles of different energy appears to confirm the validity of the scheme. A.

778.34

8168. The measurement of distortion in nuclear emulsions. M. CAULTON. *Rev. sci. Instrum.*, **24**, 569–72 (*Aug.*, 1953).

A quantitative study of distortion in nuclear emulsions, based on a method of measuring and calculating distortion to known accuracy, has been made. The method has been applied to a study of variations in fixing, washing and drying procedures. Distortion reduction up to one-half was found to occur with the use of a concentrated sodium sulphate hypo solution. The reduction of vertical shrinkage and the use of thicker emulsions also appear to reduce distortion. The method of distortion measurement is accurate to better than 10% using sea-level cosmic-ray background tracks as a distortion indicator. A.

778.34 : 535.24

8169. Photometric measurements of tracks in nuclear emulsions. M. DELLA CORTE AND M. RAMAT. Note in *Nuovo Cimento*, **9**, 605–9 (*July*, 1952).

The blackening of low-energy tracks in nuclear emulsions is determined by a photometric method. Results are discussed and it is shown how a value for the resolved track area may be obtained. Finally it is shown that by an appropriate analysis of photometric profiles, corresponding to slits of increasing width, the error introduced by the light scattered in the emulsion may be eliminated. A.

778.34 : 539.18

8170. The grain density in the tracks of 117- and 222-MeV π^- mesons in emulsions. A. H. MORRISH. Letter in *Phys. Rev.*, **91**, 423 (*July* 15, 1953).

New results are given for the grain density in Ilford G5 emulsion *v.* W/mc^2 where W is the total energy. Tracks were measured for beams of π^--mesons from a synchrocyclotron, and for 25–60 MeV electrons. The results are compared with earlier work [see Abstr. 5109 (1953)] and with the theoretical curves of Schönberg and of Halpern and Hall, but there is no conclusive evidence in favour of either curve. S. T. HENDERSON

778.34 : 539.185.08

8171. Nuclear emulsion techniques for the measurement of neutron energy spectra. L. ROSEN. *Nucleonics*, **11**, 32–8 (*July*, 1953).

The methods for processing nuclear emulsions, and the microscopes used for track measurements at the Los Alamos laboratory are described. The analysis of neutron spectra from extended anisotropic and point sources, by observation of recoil proton tracks is discussed. L. R. SHEPHERD

778.6

8172. Colour photography. R. B. COLLINS AND C. H. GILES. *J. Soc. Dyers Colourists*, **68**, 421–57 (*Nov.*, 1952).

A review covering history, colour vision, colour reproduction processes, colour cameras, colorimetry, chemistry of colour image formation, and including a commercial name index and bibliography.

778.6

8173. Multiple internal reflections in photographic color prints. F. C. WILLIAMS AND F. R. CLAPPER. *J. Opt. Soc. Amer.*, **43**, 595–9 (*July*, 1953).

The apparent reflectance of a submerged object is strongly influenced by refraction and reflection at the surface of the submerging medium. These actions affect stain and colour purities in photographic colour prints, the reflecting bases of which are submerged in gelatin. Print reflection densities can be calculated from base reflectance and gelatin transmittance; a family of graphs of the relationships is presented. By a simple modification, reflectometers can be made to measure directly the reflectance of objects submerged in transparent media. A.

778

8174. Spectral and luminance requirements color-transparency illuminators. A. L. SOREM A C. N. NELSON. *J. Opt. Soc. Amer.*, **43**, 689- (*Aug.*, 1953).

The optimum rendition of colours in a photograp colour transparency requires an illuminator wh provides adequate amounts of energy in the bl green and red regions of the spectrum. A criter has been found which determines whether this c dition is satisfied by a light source. The lumina level of illuminator viewing panels should be h enough so that shadow details are seen prope The optimum luminance is approximately 400 fc lamberts. The chromaticity should be such that illuminator appears white. For average viewing c ditions, a light source having the relative spec energy distribution and chromaticity of a comp radiator at 4000°K has been found to be hig satisfactory. Best results will be obtained w the chromaticity of the light in the room where illuminator is used the same as that of the i minator. The same spectral and chromaticity requ ments apply to illuminants for viewing reflect colour prints.